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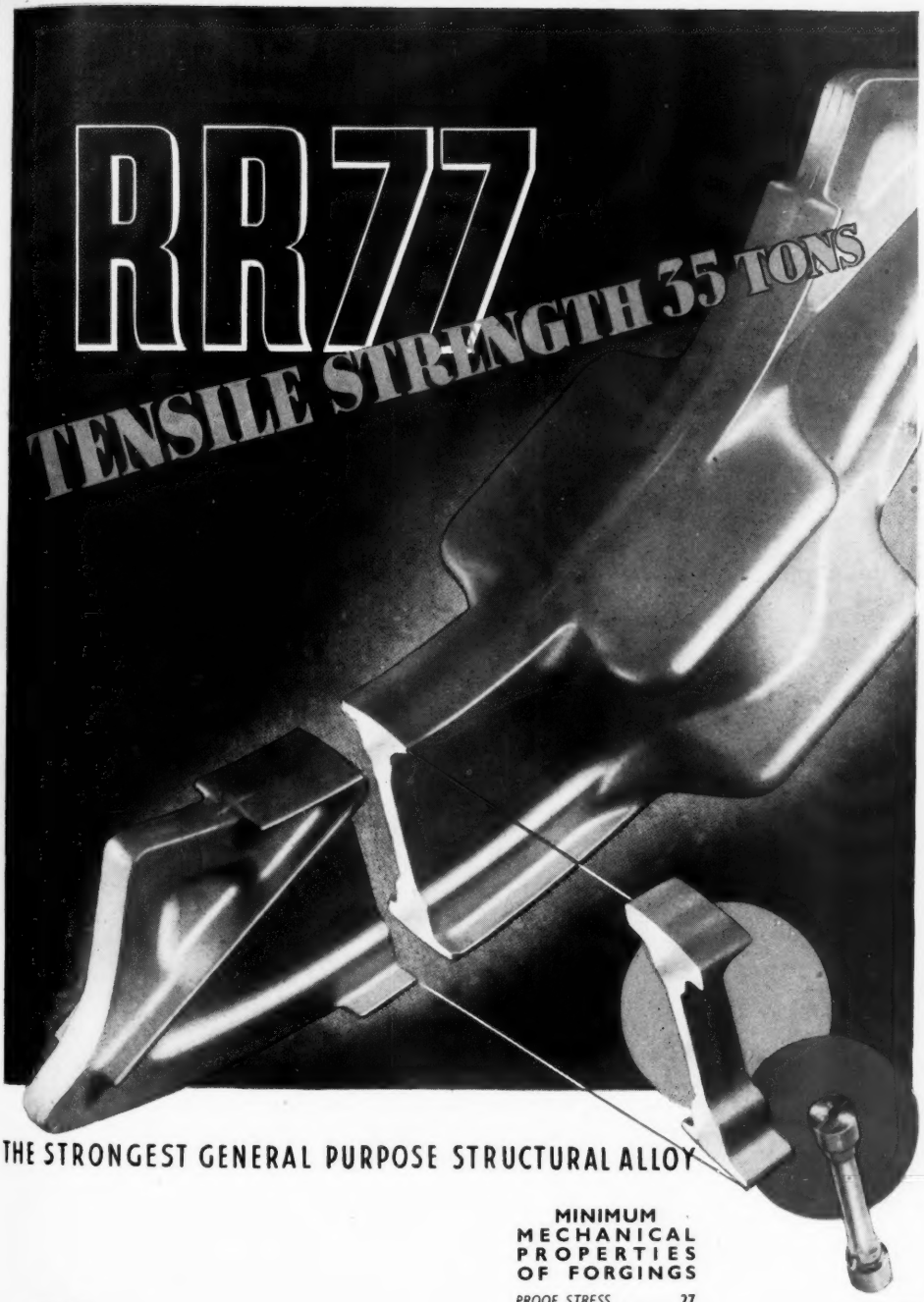

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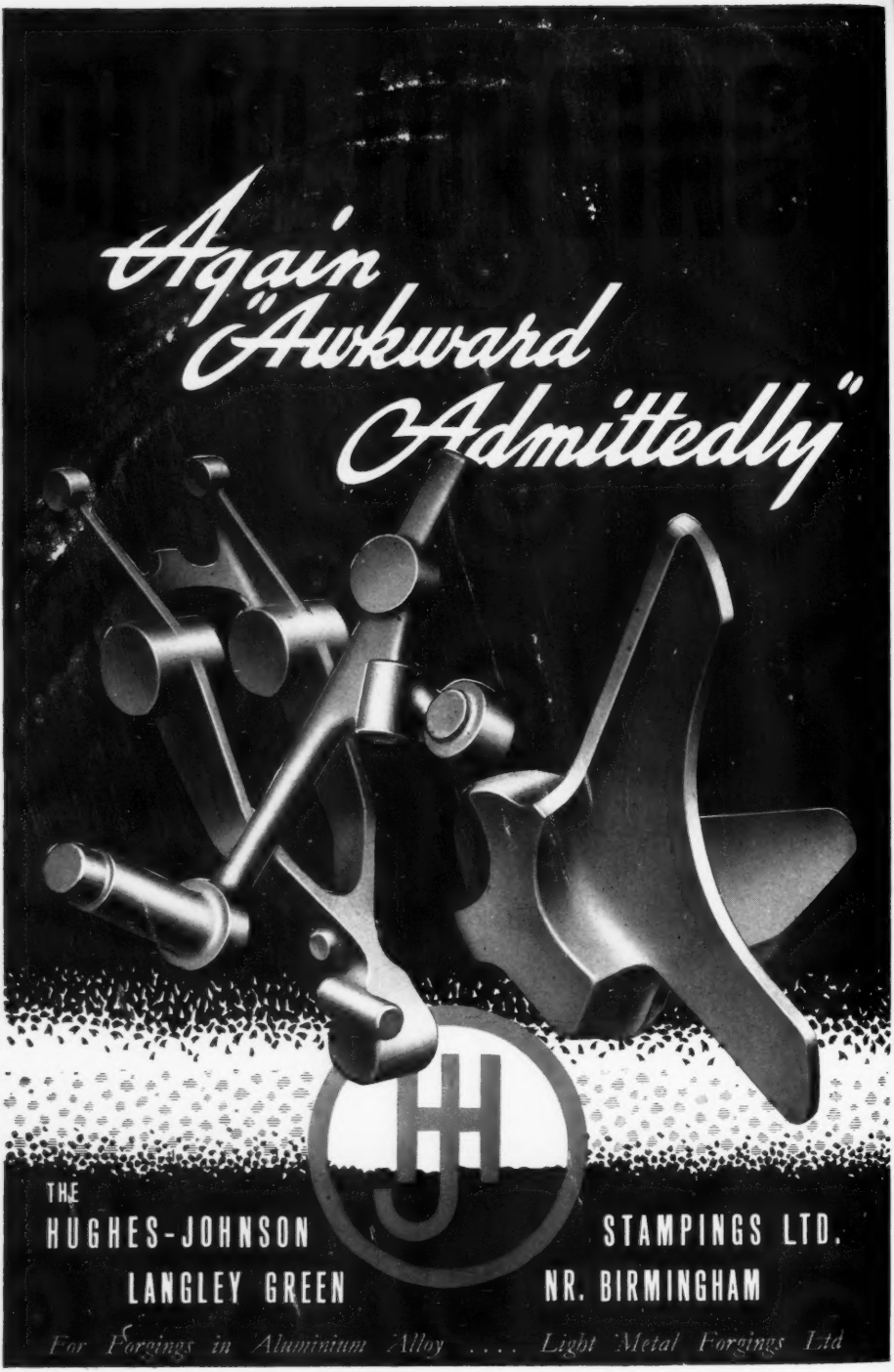

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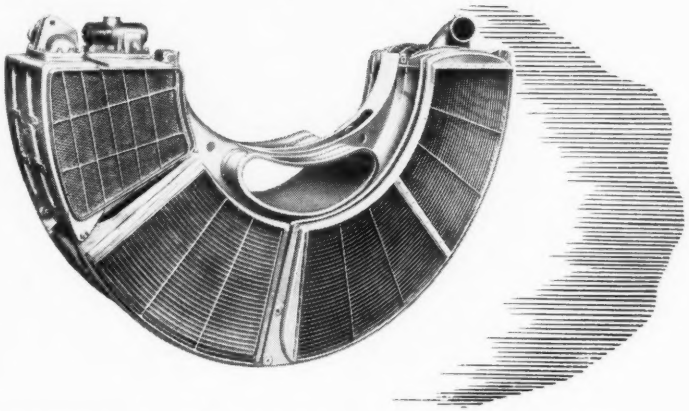

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THE SOCIETY'S PRIZES

The Society offers a number of valuable prizes, most of them annually. Full particulars of the conditions attaching to the awards of these prizes may be obtained on application

Society's Gold Medal

This is the highest honour which the Society can confer for work of an outstanding or fundamental nature in aeronautics.

British Gold Medal for Aeronautics

The British Gold Medal for Aeronautics is awarded for an achievement leading to advancement in aeronautical science.

Simms Gold Medal

The Simms Gold Medal is awarded annually for the best paper read in any year before the Society on any science allied to aeronautics, e.g., meteorology, wireless telegraphy, instruments.

The George Taylor (of Australia) Gold Medal

The Taylor Gold Medal is awarded annually, at the discretion of the Council, for the most valuable paper submitted or read during the previous session.

Wakefield Gold Medal

The Wakefield Gold Medal is awarded annually to the designer of any invention or apparatus tending towards safety in flying, and is open to members or non-members.

Society's Silver Medal

The Society's Silver Medal is awarded, at the discretion of the Council, for some advance in aeronautical design.

British Silver Medal for Aeronautics

The British Silver Medal for Aeronautics is awarded for an achievement leading to advancement in aeronautical science.

Society's Bronze Medal

The Society's Bronze Medal is awarded, at the discretion of the Council, under the same conditions as those for the Silver Medal, but for some less important advance in aeronautical design.

Wilbur Wright Memorial Premium

The Wilbur Wright Memorial Lecture is held annually, a premium of fifty pounds being awarded to the lecturer invited by the Council to deliver the lecture. The lecture is usually given alternately by an American and an Englishman, and is the most important aeronautical lecture of the year. It is delivered whenever possible, on the last Thursday in May of each year.

British Empire Lecture

The Council of the Royal Aeronautical Society have completed the arrangements for the founding of a British Empire Lecture.

The lecture, on any aeronautical subject approved by the Council, will be delivered annually in September in London, by a lecturer, chosen in alternate years from the British Dominions and Colonies and Great Britain.

The Council, by founding this British

Empire Lecture, are anxious to encourage new ideas and new points of view from all parts of the British Empire, and to make the Lecture second only in importance to the Wilbur Wright Memorial Lecture.

The British Empire Lecture will have a premium of £50 attached to it, and in the case of lecturers coming from the Dominions and Colonies an allowance up to £100 will be paid towards the Lecturer's expenses.

It is proposed to hold the first lecture in September, 1945, and suggestions for lecturers should be received by May 31st, 1945, at the latest.

R.38 Memorial Prize

The R.38 Memorial Prize is offered annually for the best paper received by the Society on some subject of a technical nature in the science of aeronautics, preference being given to papers which relate to airships. The prize is twenty-five guineas.

The Herbert Akroyd Stuart Lectures

Under the will of the late Mr. Herbert Akroyd Stuart a sum of £700 is held in trust by the Society for the offer of a prize every two years, for the best paper or lecture read or given before the Society dealing with the Origin and Development of Heavy-oil Aero Engines. The prize is open to members and non-members.

Edward Busk Memorial Prize

The Edward Busk Memorial Prize is offered annually for the best paper received by the Society on some subject of a technical nature in connection with aeroplanes (including seaplanes). Its value is twenty guineas.

Pilcher Memorial Prize

The Pilcher Memorial Prize is offered annually, at the discretion of the Council, for the best paper by a Student on heavier-than-air craft or any analogous subject. Its value is five guineas.

Usborne Prize

The Usborne Prize is offered annually, at the discretion of the Council, for the best paper by a Student on some subject in connection with Aero Engines. Its value is five guineas.

Major Baden-Powell Memorial Prize

The Major Baden-Powell Memorial Prize is awarded in May and December of each year to the student who is considered the best student by the examiners in the Society's Association Fellowship examinations. Its value is three guineas.

Elliott Memorial Prize

The Elliott Memorial Prize is awarded twice yearly to the apprentice at Halton who has the highest percentage of marks in the passing-out examination. Its value is $2\frac{1}{2}$ guineas for each award.

R. P. Alston Memorial Prize

The R. P. Alston Memorial Prize is awarded to any Graduate or Student of the Society for work done leading to improvement in the safety of aircraft, and particularly for improvement in stability and control. Its value is approximately £5.

Branch Prize

The Council offer an annual prize of twenty guineas for the best paper read before the Branches during the previous lecture Session. The prize is open to any member of the Society or of any Branch.

Journal Premium Awards

The Council has set aside an annual sum of £250 to be given as premium awards to authors of papers published in the Journal.

AN APPRECIATION

The Council of the Royal Aeronautical Society wish to thank those Companies who, by their generous co-operation, have done so much to help in the production of the Journal in its new form.

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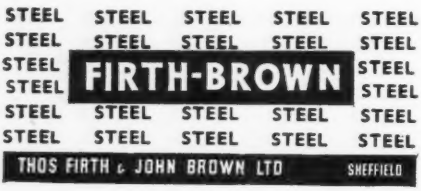

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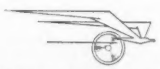

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CONTENTS *JUNE, 1945*

NOTICES .. .. 295—298

33rd WILBUR WRIGHT MEMORIAL LECTURE—AVIATION'S PLACE IN CIVILIZATION
By T. P. Wright, D.Sc., Hon.F.R.Ae.S. F.I.Ae.S. .. .. .. 299—342

TEST FLYING
Squadron-Leader J. R. Tobin, A.F.C 343—352

AIRWORTHINESS OF CIVIL AEROPLANES
By W. Tye, B.Sc., A.F.R.Ae.S. 353—360

CORRESPONDENCE .. .. 361—367

REVIEWS 368

THE SOCIETY'S PRIZES .. .. vii—viii

DIRECTORY OF ADVERTISERS xxvi—xxx

The Journal of The Royal Aeronautical Society was founded in 1897 in succession to the Annual Reports. For the opinions expressed in Papers that are signed or initialled the authors alone are responsible. None of the papers or paragraphs must be taken as expressing the opinion of the Council of The Royal Aeronautical Society unless such is definitely stated to be the case. **The Journal is published monthly at the Offices of the Society, 4, Hamilton Place, Piccadilly, London, W.1.** Subscriptions per annum, £4 10 0 post free; Single Numbers 7/6 or 7/9 post free. All communications for publication in the Journal, or on general matters affecting the Society should be addressed to—The Secretary, J. Laurence Pritchard, 4, Hamilton Place, W.1. The Society's Bankers are Messrs. Coutts and Co. All communications respecting Advertisement matters should be addressed to—The Advertisement Manager, Journal of The Royal Aeronautical Society, 4, Hamilton Place, W.1.
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JUNE NOTICES 1945

JOURNAL PREMIUM AWARDS

The Council have set aside an annual sum of £250 for the award of premiums for papers published in the *Journal* and the Council hope that members will contribute papers on their own special subjects.

Contents of the Journal

33rd Wilbur Wright Memorial Lecture: Aviation's Place in Civilisation, by T. P. Wright.

Test Flying, by Sq. Ldr. J. R. Tobin.

Airworthiness Requirements, by W. Tye.

Election of President

At the May Meeting the Council elected Sir Frederick Handley Page, C.B.E., F.R.Ae.S., as President of the Society for the year 1945-1946. The President elect takes office on October 1st, 1945.

Vice-Presidents

At the May Meeting the Council elected Dr. H. Roxbee-Cox, F.R.Ae.S., and Sir Oliver Simmonds, F.R.Ae.S., as Vice-Presidents for the year 1945-1946. The Vice-Presidents elect take office on October 1st, 1945.

Librarian

A vacancy occurs at the Society for a full-time Librarian. A knowledge of German and French and technical knowledge would be an advantage. Those interested should apply in writing to the Secretary.

Peterborough Branch

Members living in the district of Peterborough are desirous of forming a Branch there. Will those interested please write to Flight Lieut. G. N. Snarey, A.F.C., Wellsford House, London Road, Sleaford, Lincs.

Graduates' and Students' Section

VISIT TO MESSRS. HANDLEY PAGE LTD.

A visit to the Cricklewood works of the above has been arranged for the afternoon of Sunday, August 12th. Any Graduate or Student wishing to attend should send a post-card to the Secretary of the Section, 27, North View, Eastcote, Pinner, Middlesex, giving his name, address, employer or college and National Registration Identity Card number. All applications should be made before July 1st, 1945.

Associate Fellowship Examinations

The following have recently passed the Associate Fellowship Examinations:—

A. Babany (Egypt)—Applied Mathematics; Aerodynamics; Theory of I.C. Engines.

T. V. W. Bailey (South Africa)—Air Survey and Aerial Photography.

A. O. Dervishyan (Egypt)—Pure Mathematics; Aerodynamics; Strength of Aero Materials and Theory of Structures.

F/O A. W. Dingle (New Zealand)—Applied Mathematics; Theory of I.C. Engines; Design (Aero Engines).

Election of Members

The following members were recently elected:—

Associate Fellows

Archibald Buchanan Barbour (from Companion), Henry Jack Brooks, Yehuda Giladi (from Graduate), John George Gill (from

Student), John Graham, Harold George Howell (from Graduate), Clifford Kell (from Graduate), Jerzy Wladyslaw Lipka, Jozef Koziarski, Bert Walter McMullen, George Kenneth More (from Graduate), Alexander Tupalski.

Associates

Thomas Desmond Hudson Andrews, Harold William Russell Banting, John Frederick Barlow (from Student), John Baxendale, Norman Beaumont, Cecil William Henry Bebb, Harold Best-Devereux (from Student), Austin Hamilton Bradley, Eric Francis Brereton, Richard Henry Corthorn Brousson, Graham Donald Cameron Burn, William John Rawson Calvert, George Joseph Carayan (from Graduate), John Robert Clark, Jack Charles Cohen, Ernest Edward Collins, George Douglass Cooper, Douglas George Coupe, Edward Reginald Payne Crawfurd, Wilfrid George Mervyn Crews, Archie James Dilloway, Thomas Donnelly, Peter Draper, William Arthur Edwards (from Companion), Ernest Raymond Ellis, Eric Arthur Ellison, Henry Alexander Sherwin Gothard, Coenraad Christoffel Groenewald, Roy Norman Haggar, William George Haggitt, Raymond Alan Albert Harding, Walter Henry James Hewett, George Christopher Hibbert, Frank Henry Higgs, John William Holmes, Bernard Charles Horsnell, Arthur Neville Jarvis, Charles Edward Johnson, Frank Llewellyn Jones, Norman James Kent, Thomas Aubrey Kestell, Roger Orlando Lightening, James Elder Lynn, Vivian John James Krogh, George Percy Loryman, Llewellyn Adolphus Lisle, Thomas James Locke, John Alexander Lyon, David MacKintosh, John Wesley McKelvey, Thomas McLellan, John Maguire, Godfrey John Morgan, Alfred Denis Margrett, Peregrine Martin, Daniel Thomas Horatio Mintey, William James Mitchell, Edwin Arthur Nash (from Student) Thomas Wilton Newbould, Herbert Robert Offley, Alfred John Peckham, Douglas Paling, William Patrick, Dahlke Migara Ratnatunga, George Arthur Regan, Horace Laurie Robinson, George Roland Robinson, Stanley William Arthur Searle, John Luston Sloan, Jack Edwin Smith, Ian Somerville, Walter Sterne, Patrick Max Travers-Clark, Donald Watson Tripp, Norman Charles Truss, Frederick Stephen Turner, Leslie Tunstall Walker, Kennedy Watson, Ernest Henry William Ward, Frederick George Weston, Hugh George Williams, Richard Robert Whitaker, Bernard Alfred Wicks, Roland George Basey Wilson, Ahmed Nasr Eldin Zamzam (from Student).

Graduates

George Thomas Winton Bees, Alan Berin Penrose Beeton, Roy Desmond Boot, Raymond Albert Vincent Byron, William Mitchell Douglas, Eric Oliver Dummer, Mostafa K. El-Akkad, John Foley, Alan Victor Garratt (from Student), Peter George Rance Haines, Lionel Russell Jenkins, Albert Oliver Ormerod, Andrew Ivor Pollard (from Student), George Edward Preece, John Radford (from Student), Ahmed Yousif Talaat El Sayed, Joseph Singer, Aubrey Stone, Ian Thomas Alexander Murchie, Peter William Wreford-Bush, Mohamed Abdel Megid M. Zimaity.

Students

Anthony Aldridge, Charles David Allen, Philip Goolden Astles, Percy Geoffrey Ball, Arthur Alfred Baines, Edward George Underwood Band, Rollin Hamilton Bates, Stanley William Booker, Jack William Brown, Brian John Rollin Boney, Richard Gerald Burke, Christopher Edwin Burrows, Jerrold Peter Chisholm, Jamsled Minocher Cowasjee, Roy Edmond Dangerfield, Richard Saxon Duke, John Dixon Ellwood, David Trevor Evans, Edwin Henry Hall, Alfred Gordon Harris, Raymond Vincent Lester, Ian Alfred Thomas Lumsden, Peter Meiklem, Barrie Desmond Morris, Kenneth McLean Park, John Reginald Pope, Sidney Henry Warren Prince, Ivor Leslie Kerr Rye, Robert Saunders, Derick Shaw, William

Hugh Murray Swann, Tudor William Thomas, John Gall Thomson, Thomas Turner, Ian Donald Eric Webster, Frederick Lewis West, Gerard John White, Ronald Bruce Wyke.

Companions

Hubert Bryan Johnson, Catherine Patricia White.

Acknowledgments

The Council acknowledge with thanks the gift of Journals from Mr. J. D. Campbell, Associate Fellow; Mr. E. W. Percival, Fellow; and Mr. I. M. Cahill.

Additions to the Library

Pamphlets in italics with location reference following in brackets. Books marked * may not be taken out on loan.

A.d.28.—*A Method of Calculating the Wall Correction for Elliptic Tunnels. V. M. Ghatage.* (*Reprint, Proc. of Indian Acad. of Sciences*), 1945. (Y.1.d.7.)

B.a.334.—The Book of Miles Aircraft. A. H. Lukins. Harborough Publishing Co., 1945. 10/6.

BB.c.99.—*Research on Model Airscrews.* (*Reprint of lecture given at Volta Conference, Rome,* 1935.) *G. P. Douglas. Reale Accademia d'Italia,* 1935. (Y.1.b.6b.)

D.a.B.90.—*International Civil Aviation Conference, Chicago* (1944). *Part* I: *Final Act and Appendices I-IV.* (*Cmd.* 6614.) H.M.S.O., 1945. 1/-.

D.a.B.91.—*Air Transport Policy. "Four Conservative M.P.s." Privately Printed,* 1943. (PD.2.a.19.)

*D.b.231.—Articles of Association of the Association of British Aircraft Operators Ltd. Jordan & Sons (Printers), 1944.

*D.b.232.—*British Overseas Airways at War.* (*5-year Report,* 1940-45), *with Tables and Statistics.* (*Stencil.*) 1945. (Y.6.i.a.43.)

D.c.101.—Report on a Scheme for an International Airport in South Wales. E. John Powell. S. Wales Civil Air Base Committee, 1945.

D.c.102.—*Warsaw Airport.* (*Post-War Project.*) *The Polish Ministry of Industry, Commerce and Shipping.* 1945. (Y.4.i.17.)

E.b.104.—Ueber die mittragende Breite. A. B. Miller. R. Oldenbourg, Munich, 1929.

F.b.41.—Standard Methods for Testing Petroleum and its Products. (6th Ed.) Institute of Petroleum, 1945.

*G.b.46.—S.B.A.C. Standards Handbook. Loose-leaf.) Vol. 10. 1945.

G.e.A.98.—*Spinning and Panel-Beating of Aluminium Alloys.* (*W.L.A.D.A. Information Bulletin No.* 9.) *Wrought Light Alloys Development Association,* 1945. (File Case.)

G.e.E.64.—*The Iron and Steel Industry.* (*Reprint from "The Times," Feb.* 24, 26, *March* 12, 1945.) *Times Publishing Co.,* 1945. (PG.6/21.)

G.f.31.—*Redux Metal Bonding. Aero Research Ltd.,* 1945. (PG.9.c.7.)

K.c.20.—Rocket Research: History and Handbook. Constantin P. Lent. The Pen-Ink Publishing Co. (New York), 1945.

L.b.43.—Pilot's Reminder Book. (2nd Ed.) R. C. Morgan. Air Transport Auxiliary, 1945.

M.b.53.—*The Elementary Principles of Wireless. W. E. Flood. Longmans Green,* 1945. 1/6. (PM.2.a.4.)

*OO.117.—International Civil Aviation Conference, Chicago. (Nov.-Dec., 1944): Final Act. Air Registration Board, 1945.

NOTICES

*Q.a.155-160.—Government Publications: Consolidated List for 1939, 1940, 1941, 1942, 1943, 1944. H.M.S.O. 1/- each.

*Q.a.161.—" Bristol " Central Library Catalogue. Bristol Aeroplane Co., 1945.

Q.b.76.—Carnegie United Kingdom Trust: 31st Annual Report, 1944.

R.f.99.—Man's Fight to Fly. John P. V. Heinmuller. Funk & Wagnalls, 1944. 30/-.

TT.a.47.—The Suzy-Q. Priscilla Hardison. (Bound galley-proofs of book issued by Houghton Nufflin, U.S.A., 1944. Novel about U.S. flyers fighting Japanese.)

UH.3.—Atti di Guidonia. (Italian Research Reports.) Complete series, Nos. 25-28 inclusive, except Nos. 59, 60, 61. (Details supplied on request.)

*UU.c.—National Advisory Committee for Aeronautics, Technical Memoranda. No. 1066. Comparative Results of Tests of Different Types of Nozzles. M. S. Kisenko. N.A.C.A. Washington, 1944. (Photostat, replacing missing copy.)

J. LAURENCE PRITCHARD,
Secretary.

33rd Wilbur Wright Memorial Lecture

AVIATION'S PLACE IN CIVILIZATION

by

T. P. Wright, D.Sc., Hon.F.R.Ae.S., F.I.Ae.S.

Administrator Civil Aeronautics, U.S.A.

Mr. T. P. Wright is Administrator of Civil Aeronautics for the United States of America. In 1925 he became Chief Engineer of the Curtiss Aeroplane Division, and in 1937 he became Vice-President of the Curtiss Wright Group. His last design was the Curtiss Commando. From 1940 to 1944 he headed the Aircraft Branch of the United States Production Board, organising the output of aircraft. He was made Honorary Fellow of the Society in November, 1942.

THE Thirty-third Wilbur Wright Memorial Lecture was delivered before the Society on Thursday, May 31st, 1945, at 6.30 p.m., in the Lecture Hall of the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, by permission of the Council of the Institution. The chair was taken by Sir A. H. Roy Fedden, F.R.Ae.S., President of the Society.

The PRESIDENT: Before calling upon the Lecturer, he had first of all another important and pleasant duty to perform, namely, to present the Society's Gold Medal to one of its Fellows. This is the highest engineering and scientific honour the Royal Aeronautical Society can bestow. It is a closely-guarded distinction, and has only been awarded seven times previously during the 80 years of the Society's existence.

The recipient of this honour was Air Commodore Whittle, an officer of the Royal Air Force, whose name was practically unknown at the beginning of this war, except to a comparatively few technicians, whereas to-day there could hardly be a country in the world where engineers were not aware of his pioneer work.

It was only 15 years or so ago that Air Commodore Whittle, assisted by a few fellow enthusiasts, set to work to develop his gas turbine for the jet propulsion of aircraft—that long-cherished dream of internal combustion engineers. Yet in that short time he had achieved such outstanding results, and had brought his work to such successful fruition at a time of national emergency, that we in Britain owed him a very great debt of gratitude. He felt sure, too, that our American friends would acknowledge a similar debt.

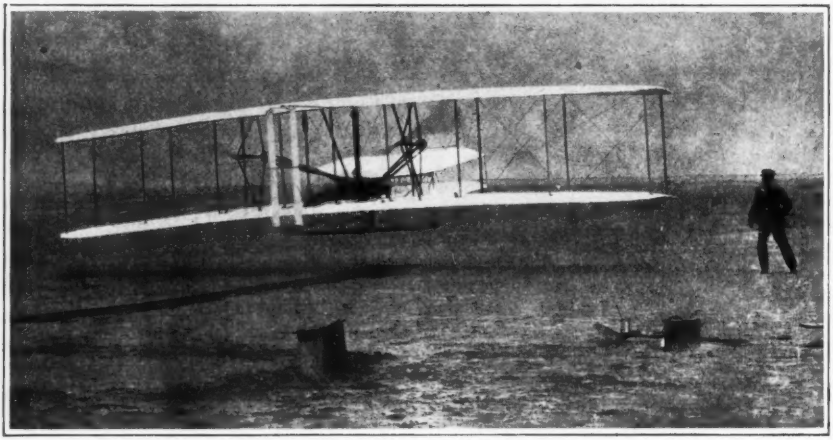
It was easy to praise and accept a man's brilliance when he had proved his ideas successfully, by actual demonstration. He had reason to know that the attitude was often very different in the early pioneering days of any new project, when those who should be encouraging, were either indifferent or disinterested, and money for development was hard to come by.

That was the real testing time, and we

honour Air Commodore Whittle, not only for his technical ability and vision in regard to jet propulsion for aircraft, but also for his fortitude and fanatical belief in the soundness of his ideas, in the face of almost overwhelming odds and setbacks. Without this enthusiasm and determination he doubted very much whether he would ever have won through in time to provide a power plant which had given us the fastest fighter in the world just at the end of this war.

As was customary on such occasions, as President, he had cabled Orville Wright as follows:—

Orville Wright, 15, North Broadway, Ohio, U.S.A.—On May 31st your distinguished countryman, T. P. Wright, will read the Thirty-third Wilbur Wright Memorial Lecture on "Aviation's Place in Civilisation." On behalf of the Council and all members of the Royal Aeronautical Society I send to you our deep-felt greetings. To the aeroplane we have



The first controlled and sustained flight, December 17, 1903, Orville Wright piloting the machine; Wilbur Wright on foot.

He had every conviction that in the years to come Air Commodore Whittle's outstanding pioneer work would lead directly to the production of aircraft having long sought after refinements, and capable of speeds which were unapproachable to-day.

It was with great personal pleasure that he presented the Society's Gold Medal to Air Commodore Whittle for his great contribution to aviation.

(The presentation of the Society's Gold Medal to Air Commodore Whittle was accompanied by long applause.)

Before introducing the lecturer he had great pleasure in reading two telegrams he had received.

owed during these last five years so much in the fight for freedom that we look forward confidently to the time when it will, in the future service of mankind, bring such a deep understanding among the peoples of the world, that it will never again be looked upon as an instrument of war.

ROY FEDDEN, President,
Royal Aeronautical Society.

And had received the following reply:—

Greeting to officers, members, and to my good friend T. P. Wright, who will speak on "Aviation's Place in Civilisation." The aeroplane has finally vindicated itself in the preservation of civilisa-

tion. Its ruthless use in the hands of selfish and ambitious peoples can be rendered impossible in future if all civilised nations suppress selfish commercial interests, while a world-wide organisation for the enforcement of peace is being perfected. Yours for a lasting peace,

ORVILLE WRIGHT.

He had also received the following cable from the Institute of Aeronautical Sciences:

Institute sends greetings on occasion of our distinguished Past-President, T. P. Wright, presenting Wilbur Wright Memorial Lecture. The Royal Aeronautical Society has carried on through the European War with fortitude. We honour the staff for its courage and loyalty. May both societies continue to co-operate as closely as in the past and V.J.-day come as completely as all would wish.

LESTER D. GARDNER.

He had now great pleasure in introducing the Lecturer, Mr. T. P. Wright, an Honorary Fellow of the Society, an American aeronautical engineer of world-wide experience and repute, a great champion of Britain, and to many there, a close friend.

The Wright Memorial Lecture was the most important event in the calendar of the Royal Aeronautical Society, the first institution in the world to be devoted solely to aviation. The lecture was established to commemorate the outstanding pioneer work of the Wright Brothers, who made their first successful flight in America with a heavier-than-air machine in December, 1903. By its constitution it was an annual event, and the lecturer was alternately an Englishman and an American. We may well be proud of the fact that it had been held without a break for the last 33 years, continuing in unbroken sequence through the difficult periods of the two great wars, although it was touch and go five years ago, in May, 1940, whether the sequence could be kept intact. Now after nearly six years of the most terrible war in history, and less than a month after the unconditional surrender of Germany, we were to hear the 33rd Lecture. It was fitting, he felt, that this year it should fall to the lot of an American to deliver it.

He felt deeply moved at having the honour to introduce the Lecturer on this momentous occasion, so soon after the triumph of the aeroplane as a primary factor in the overthrow of Nazi tyranny. In his opinion no more appropriate personality than his old friend Mr. Wright could have been found, if only on account of the great work he had done in his own country for aviation during this war.

Mr. Wright, in the introduction to his lecture, made some interesting references to his early training and experience, but he would like to emphasise just one or two points in his career, which, in his opinion, singled him out as being the one man among all others who should be speaking to-night.

After graduating in engineering, with honours, Mr. Wright served as a naval lieutenant on aircraft inspection in the last war, but soon changed over to the civilian design side, where he rapidly achieved brilliant success. He designed a long series of successful Curtiss aircraft, including the Hawk, Falcon, Helldiver, Condor, and many others, and he also designed the winning Curtiss Pulitzer and Schneider Trophy racers.

In 1925 he became chief engineer of the Curtiss Aeroplane Division; in 1931, he was put in charge of their experimental and research activities, and in 1937 he became Vice-President of the Curtiss-Wright group. His last design was the Curtiss Commando, which has done excellent transport work during the war.

It will be seen therefore that Mr. Wright is an aeronautical engineer of outstanding merit, and second to none in the United States.

In 1940 Mr. Wright left industry, and was called to Washington to serve on the National Defence Advisory Council. Later he headed up the Aircraft Branch of the United States Production Board, and did more than any one man in his country on the organisation, co-ordination and recording of that stupendous output of aircraft called for by the late President Roosevelt.

In October, 1944, having already shown himself to be an outstanding aircraft technician and designer, as well as a brilliant government production organiser and statistician, he took on an entirely new job of great responsibility, namely, Civil Aviation Administrator for the United States, embracing all the intricacies of aerodrome management, Federal regulations, safety, radio and radar regulation, and foreign aircraft rules and liaison. These matters were for the most part entirely new to him, but, controlling a staff of 10,000, in seven months he had made an outstanding success of this task also.

In the autumn of 1938 Mr. Wright read a classic paper which, for the first time in the history of the Society, gave a clear exposition of how to tool and produce modern aircraft on an interchangeable basis. At about this time he also wrote a number of brilliant articles in the British Press, pointing out the German production potential and giving a comparison of British, American and German outputs.

He would venture to say that, in Mr. Wright, we had a man of unsurpassed vision and versatility in aviation, and he now had much pleasure in calling upon him to deliver his lecture.

Mr. T. P. WRIGHT (Honorary Fellow): How admirable was the decision of that early Council of the Royal Aeronautical Society when inaugurating the Wilbur Wright Memorial Lectures, to alternate their presentation between persons from England and the United States. It gives a recurring occasion for those of us from the other side of the Atlantic privileged to have been selected, to reaffirm our friendship for you; to exchange information; and to present our point of view on aeronautical subjects of timely interest. In this, as in many things, we in America have followed your example by our establishment of the Wright Brothers' Lecture of the Institute of Aeronautical Sciences, on a similar basis. I am here reminded of a quotation from De Tocqueville—" When men feel a natural compassion for each other's ills, when easy and frequent relations bring them every day closer and no susceptibility divides them, it is easy to understand that at need they will mutually assist one another. The moral force inherent in a sympathetic understanding between the two great English-speaking peoples is of inestimable worth."

A re-reading of the list of notable persons that have been chosen by the Council to read this lecture would of necessity make anyone keenly aware of the honour extended to him when asked to join that illustrious group. I assure you of my own deep appreciation in being afforded the opportunity of presenting the thirty-third Wilbur Wright Memorial Lecture.

INTRODUCTION.

" Aviation's Place in Civilization " is the subject of my lecture. It was with considerable trepidation that I made the selection of such an ambitious title, but I felt compelled to tackle this subject, perhaps impelled by reflections during many years on the need for appraising the implications, for good or ill, that my chosen profession possesses in the general scheme of things. As we approach victory in this greatest of wars, the need becomes more pressing. I ask your indulgence in presenting a little personal history, as only by so doing can you share with me my speculations on the need for universal reappraisal of the fundamental import of aviation.

I started out as an officer in Naval

Aviation in World War I. After the war there followed a period of designing, engineering and manufacturing of aircraft. The objective of these labours, except for brief excursions in the racing field and some consideration of civil aircraft in the late 1920's, was the production of military aircraft—of war machines. This did not seem to me then to be a very worthy direction of effort. Could not the airplane serve humanity better?

Next, I entered an intensively interesting field as Engineering Executive, a position that afforded occasion for travel. My first trip to Europe was in 1934, at which time I had my initial opportunity of visiting many of your aircraft factories and becoming acquainted with many people in your industry. Aviation was then a small industry with such production as there was, concentrated on military aircraft; but strangely enough, and significantly, I sensed that the fundamental interest, as in America, was on the civil side. How we all enjoyed the King's Cup Races in those days!

Then, in 1936, I went to Germany and had my eyes opened; saw production of military aircraft in numbers many times the combined output of the United States and United Kingdom, and very obviously, not intended for National Defence, but for aggressive war. As no force-implemented League of Nations or other effective medium of collective security existed, I was regretfully forced to accept the fact that the democracies, having already lost the peace that followed the first World War, must, if they were to survive, prepare intensively for the Second. Our potential enemies had selected the weapon; their strength was great and time was short.

In 1938, just after Munich, I was honoured by a request to read a lecture to your Society on "American Methods of Aircraft Production." This, and a talk at a dinner which followed, gave opportunity to reiterate the warnings of German strength and intentions as they appeared to me, and the need to share the burden of meeting the threat. The war came—Europe was overrun—and England stood alone. With a handful of Spitfires and Hurricanes (of surpassing excellence), with the "few" of outstanding courage and determination, and with a leader of indomitable will, backed by the people of England who wouldn't be beaten, civilization was saved.

In the United States President Roosevelt announced his aircraft production expansion programme and set it at a high enough level to test our abilities to the limit.. I moved to Washington in 1940 to contribute, as a Public Servant, all I could to the achievement of our production objectives.

In the fall of 1942 I had an opportunity to visit you again, this time with a production mission of American aircraft manufacturers. How greatly we were impressed with all that we saw: your production effectiveness, your spirit, your determination in the face of almost unbearable hardships! Again a year ago, I flew the Atlantic, this time on a military technical mission whose objective (our aircraft production battle having been won), was freely to discuss with your technical people those developments on which we were each working, and thereby to assist each other to improve the "breed" of our aircraft so as to hasten victory. By last fall, the state of the war made it seem appropriate, though I fear it proved to be premature, to accept a post in the field in which I am sure we all had longed to participate—civil aviation.

My only object in reciting this all too personal story is to emphasise the desire which I have had, and am sure the vast majority have, of seeing the airplane so utilised as to make it a positive force in the progress of civilization.

In the remainder of the lecture I shall attempt to appraise these possibilities, to analyse the airplane's potential for good, and to draw such conclusions as appear warranted. For convenience in visualising the

plan, there follows a brief outline of the topics discussed:—

1. The Problem.
2. The Scientific Approach.
3. Historical Aspects of Transportation.
4. Military Aviation and War.
5. Government and Civil Aviation.
6. Technical Development.
7. Fields of Usefulness for Aircraft:
   - Economic Uses
   - Transportation
   - Communications
   - Cultural Considerations
   - The International Field.
8. The International Civil Aviation Conference at Chicago.
9. Collective Security.
10. Conclusions.

THE PROBLEM.

Let us first define the terms in our subject. Aviation, of course, is the art of flying. Civilization is a condition of human communities, characterised by political and social organization and order; advancement in knowledge, refinement and the arts; and continuous progress in the realisation of social, cultural and religious values. The problem which we must see and really appreciate exists is, therefore: can we so manage aviation that it will contribute to the development of civilization?

Perhaps the problem as I have envisaged it can be better seen by describing to you the alternative titles of this lecture which I had considered, depending on the degree of pessimism or optimism that I had at a particular time. One was "Aviation and the Neanderthal Man." Can the old savage be trusted with the tools which he has created? Has man the capacity to catch up with his own machines? Must the chief use of the airplane be to destroy life and property on an ever-increasing scale as its development accelerates, or can these employments be controlled and the many potential uses that it possesses for the advancement of civilization be made to predominate? Now as never before we need creative intelligence—knowledge conscientiously applied to our problem—the same kind of fearless engineering in the social and international fields that in the realm of physical science has pushed out the boundaries of human understanding so widely. For without such creative intelligence and determination to take whatever steps are necessary, regardless of sacrifices involved, man, like the Brontosaurs of the Triassic Period, that developed a protective armour so heavy that they bogged themselves in the mud and disappeared, will become mired by the weight of his own inventions.

And now another alternative title considered when in more optimistic mood: "Aviation—A Benevolent Spiral." I clung to this for some time, as it represents my real feeling that aviation is destined to be a good thing for mankind. My text for this would have led off by one of my favourite quotations, for which we are indebted to William Henson, an Englishman, whose patent covering his invention of an "Aerial Steam Carriage" in 1843 depicts an arrangement of wings, controls and power plant, extraordinarily modern in configuration. Just over one hundred years ago Henson said, "The changes which must follow the first aerial voyage of one hundred miles in length must be great, may be astounding to our present notions, may be dashed as all human advances are with subtractive evils, but they must be largely beneficial to the human family. It is no considerable earnest of future good that the very nature of the design compels us to consider all mankind as one community. When men are strangers, they are ready to become enemies; render them mutually acquainted, and they soon become mutually useful; and when their interests are at stake, we may safely reckon on their continued and abiding friendship."

Our problem is to see that the "subtractive evils" are transitory and incidental and that the principal of these (use as an agent of unparalleled destructiveness), does not

represent the main objective of this art of aviation in which we are engaged. The problem is very real.

THE SCIENTIFIC APPROACH.

I am sure that all in this audience are familiar with the scientific method. The tremendous advances of modern science and technology are based on the inductive approach, from fact to principle. In simplest form we may state our present problem as the attainment of ability to apply the scientific approach to science itself; the ability to develop technical improvement toward desirable ends; to direct our machines to useful purposes. The scientist and engineer, above all others, must reflect upon the social import of his findings. A science of society would appraise the determinations of each of the physical, mathematical, biological and social sciences as themselves facts to be correlated in a system and formulated into laws and principles of civilization. As examples of what is meant, some considerations derived from history that possibly could be so assembled, classified, correlated and formulated are cited:

The frontier community wherein every man protects himself and is "quick on the trigger" has been brought from this chaotic state by the introduction of law, backed by policing authority.

States armed individually and competitively in the name of national defence, eventually have got into war.

A league of states, itself unarmed in policing weapons has been powerless to forestall individual national rearmament and to prevent war.

(Possibly from these and other facts it could be established that a group of nations united in peaceful purpose and collectively possessing a police force of sufficient speed and mobility could prevent wars.)

Again, on the economic side, history shows that attempts at national self-sufficiency, prestige subsidies, and tariff walls have built up depressing influences elsewhere in the world that have led to wars. Over-emphasis upon the sovereign right of states, with attendant unwillingness to sacrifice anything for the common world-wide good, has forestalled the formation of effective international organization that might have been successful in maintaining world order.

(Possibly over-emphasis of nationalism and sovereign rights is inimical to the peace and prosperity of nations.)

It has often been thought untenable to hold that different nationalities could fight together effectively, and yet the present war, where joint commands and operations have been the rule rather than the exception, have disproved the assumption.

Geographical isolation has, heretofore, been considered effective in keeping certain nations away from war, but today the world-wide interdependence of nations accentuated by the machine age has made reliance upon such isolation a thing of the past. The airplane binds all states even closer together.

(Possibly an international air police force, as long advocated by the late Lord Davies, will work.)

Advancement in the physical sciences has surely far outstripped our ability to cope with government problems, with social problems, with international problems and with economic problems. The thought is pointedly stated by Susanne Langer in an article, "Make Your Own World."

"The use of technology has changed the character of war from combat between men to a gigantic conflict among destructive machines. And this change coincided with another, also due to technology—the unification of the whole world into one economic nexus, one concert of nations (which used to comprise only Europe), and one vast theatre of war. Consequently when hostilities are going on there is no hinterland where the arts of peace are preserved. . . .

"In a world that is, de facto, a com-

munity of nations, the claim of each national state to sovereignty, or unbridled freedom, is as fantastic as the proposal of our political anarchists to dispense with civil law. Anarchy has never been seriously tried in any large community of men. Its most probable results . . . are just too probable. Yet in the community of nations it is the prevailing system . . . and its actual results are exactly what one could expect."

Civilization has been threatened twice in a generation. It is certainly worth the effort as a measure of self-preservation to apply the scientific approach to a study of the inter-relation of these basic sciences, now, as failure to do so may next time be fatal.

In this discussion I am assuming that the prime desideratum is to progress to a world-wide state of law and order, the antithesis of chaos and war. As J. Parker Van Zandt puts it in his inspiring book, "Civil Aviation and Peace," "Two world wars in one generation have taught us that the absolute essential, the sine qua non of human well-being and progress, is freedom from recurrent and increasingly destructive wars."

It is, I feel, necessary constantly to hold before us a desirable goal and to subordinate other considerations to it, else we will surely lose sight of it, particularly now and later as the present war recedes in point of time. Not only must we individually have such an objective in view, but we must, even at the risk of being given the stigma of "dreamer," proclaim our ideal. Without dreamers and idealists little is accomplished, as the dreams of today are always the realities of tomorrow! This does not, of course, absolve us from the duty continually to re-examine our goals with increasing knowledge and widening horizons. We must be progressive in ends no less than in means.

The speed of scientific advancement today makes immediate consideration of this problem imperative. But ideals alone are not enough—suitable tools are also needed. And here I bring in the airplane as a major tool of progress, capable of bringing the peoples of the world closer together and in furnishing the primary policing medium for a collective security system. Aviation can be a force for good, though not automatically so. To the people of Europe and China, whose chief knowledge of the airplane has been a drone and then an explosion, there will be reluctance to think of aircraft in that light. Yet I must proceed on that premise and state that although the impact of the air age is great, it will be good and will make for ultimate world order.

HISTORICAL ASPECTS OF TRANSPORTATION.

Aviation is a means of rapid transportation, whether used to move mail, express, goods or bombs on the one hand, or people on the other. Also, a slightly different connotation, it is a method for securing fast communications, when transporting mail or persons.

Truly it has been said that "the very pace of life depends upon the speed with which matter can be converted into energy available for transportation." Advancements have been rapid as each new discovery speeded up the transportation means. The accompanying pictures, reproducing cards obtained several years ago at the Science Museum in London, illustrate the stages of development. (I have added a final one, the Douglas DC-4, to bring the series up-to-date.) Starting in the Stone Age with "leg" power at about three miles per hour, man progressed to the sledge, the pack animal, the roller, the wheel (a truly great stride), the boat (sail then steam), the steam train, the automobile, and finally in our time to the transport aircraft possessing cruising speeds of approximately three hundred miles per hour, and with much more in prospect. Perhaps the rocket, with velocities greater than that of sound, should be cited as a more distant step, having possibilities of

TRANSPORT THROUGH THE AGES (1)

This scene depicts the earliest method of transport, when man carried every burden on his own shoulders. We see a man of the early Stone Age carrying home a dead pony, whilst a woman and her child are crossing the river on a log. Executed by R. T. Roussel.

useful application. Yes, modern civilization rests upon man-made means of transportation and communication; without such means modern states could not exist.

Man being a social animal, human society is based upon communication among its members. The unity of any large group can be preserved only through the institution of long distance communication, whether by human messenger, by signal bonfire, by airplane or by radio. The extent of the group depends on the speed of communicating means. With the advent of the airplane and radio it logically becomes world-wide. Similarly, the maintenance and increase of the economic strength of a group soon becomes dependent upon long-distance transportation. Here again the airplane makes grouping on a world-wide basis feasible.

Air transport is simply transportation principally characterised by speed and a complete independence of surface conditions. Giving a present four to one superiority in time saving over long-distance rail travel and a seven to one superiority over water transportation, the magnitude of the step taken is apparent; its importance cannot be overestimated. A final characteristic of air transport that distinguishes it sharply from other means is vertical separation, the ability to use the third dimension to great advantage in a number of ways for a variety of purposes.

MILITARY AVIATION AND WAR.

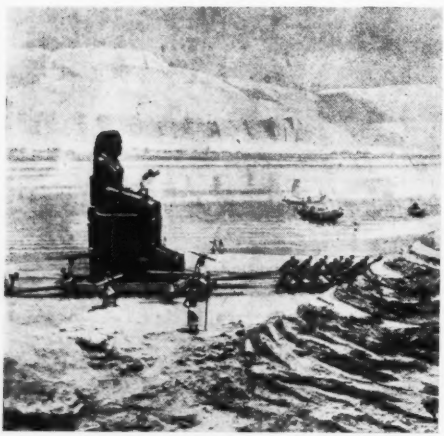
Although possibly military aviation can be said to have started in 1870, when free balloons were used during the siege of Paris, it was not until the first World War that it became of substantial importance. First uses were for observation purposes, the airplanes being frequently referred to then as the

TRANSPORT THROUGH THE AGES (2)

The first vehicle used by man was undoubtedly the sledge. This is a conjectural scene of transport in the Neolithic age, perhaps 5,000 years ago. On the lake are two large dug-out canoes.

TRANSPORT THROUGH THE AGES (3)

Men and goods have been carried on the backs of animals from before the dawn of history, and this is still a widely used method of transport wherever roads are lacking or too difficult for wheeled vehicles. This scene shows Yaks coming through a mountain pass in Tibet.



TRANSPORT THROUGH THE AGES (4)

In this scene a heavy statue is being transported on rollers on the banks of the Nile. On the river can be seen three ships of the type used in Ancient Egypt at the time when water served as the only means by which heavy goods could be transferred over long distances.

"eyes of the Army." Then counter measures in the form of fighter planes brought the "dog fight" of World War I into prominence. The role of the bomber was relatively minor.

TRANSPORT THROUGH THE AGES (5)

It is reasonable to suppose that wheels were developed from rollers, but it was only with improvement in roads that the wheeled vehicle came into wide use. This scene shows one of the many types of vehicles used by the Romans. In the middle distance is one of the large sailing ships which carried to Italy the corn of Egypt, and also a war galley propelled by means of oars.

TRANSPORT THROUGH THE AGES (6)

This is a scene in the Middle Ages when the Roman roads had fallen into disrepair and pack animals were the principal means of transport on land. The sailing ship is inferior to the Roman ship illustrated in a previous scene in that it has only one sail and could only sail before a fair wind.

In World War 2 air power has taken a position of equal importance with other service arms. In some respects the importance is greater, although any attempt to appraise relative roles of the air, land and sea arms is misleading, as it has been proved time and time again that their co-ordinated use is in most instances essential.

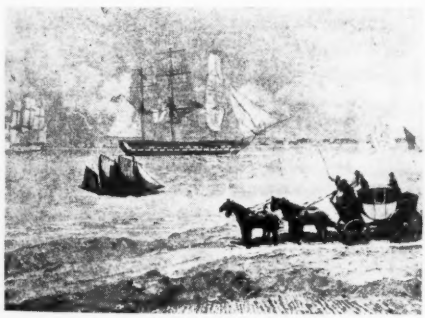
Possibly the most significant aspect of military aviation in this war is the predominant role of the bomber. Branching off into two fields, one strategic bombing, in which the potential of the enemy to make war is reduced by the destruction of his factories, power sources, oil reserves and cities; and the other tactical bombing, in which direct co-operation with ground forces is usually implied; we find in each most tremendous developments. The strategic bomber has evolved from the lumbering "crates" of the last war to the present sleek, long-range dreadnoughts of the air, typified by the Superfortress. Bomb loads have increased from measurements in pounds to measurements in tons, with individual bomb weights

TRANSPORT THROUGH THE AGES (9)

This represents a scene about 1831, at the dawn of the industrial age. It depicts the coach which was the typical means of road travel and a steam vehicle, the forerunner of the motor car, which was to replace it, also one of the earliest railways and a paddle steamer.

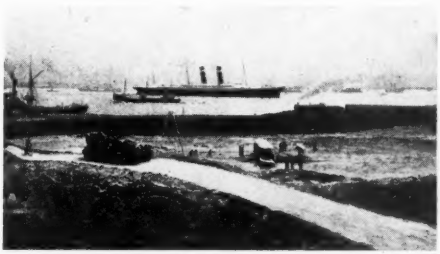
TRANSPORT THROUGH THE AGES (7)

This is a scene of the late 16th century. Roads were still very bad, but wheeled vehicles were coming into more general use. The waggon is of the type used for carrying the poorer people and their goods. The four-masted ship shows an immense improvement over those of the Middle Ages.



TRANSPORT THROUGH THE AGES (8)

This scene represents the typical forms of transport in the 18th century. Land transport is represented by a coach, water transport by one of the large East Indiamen which traded to India and China and by one of the smaller line-of-battle ships, while the beginnings of transport in the air are to be seen in the hydrogen balloon of 1783.

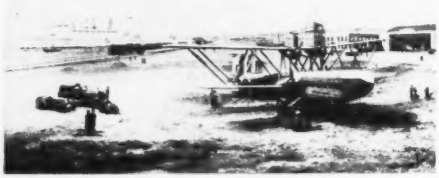


TRANSPORT THROUGH THE AGES (10)

By the year 1908 transport, as represented in this scene, had become very largely mechanised. The motor car and motor bicycle were firmly established and railways had spread all over the country, whilst the screw-propelled steamship had almost entirely replaced the paddle steamer and the sailing ship. The Wright aeroplane had just been introduced into this country.

scaling upwards from 100 pounds to over 20,000. The tactical bomber, truly a combination of flying tank and pillbox, has in many cases had mounted in its fuselage and wings as many as 14 or 15 .50 calibre guns for attack, in addition to its bomb load.

Fighters have increased in speed and fighting power commensurately, developing from World War 1's 2,500-pound machines attaining a speed of 140 miles per hour and mounting one .30 calibre gun, to long-range 13,000-pound aircraft of approximately 500 miles per hour mounting eight .50 calibre guns.



TRANSPORT THROUGH THE AGES (11) TO-DAY

The most rapid development in transport since the last scene has taken place in the Air. A modern air liner capable of carrying 40 people at over 100 m.p.h. is shown with numerous other aircraft. The " Empress of Britain," a modern locomotive, and motors cars are also illustrated in this scene.

These strictly combat types of military development must, in our appraisal, be supplemented by further development of the Robot bomb (V-1) and rocket (V-2), and later guided missiles of many varieties, which, when consideration is given to the likelihood of the future use of lethal gas, again point the moral, the need exists for subordinating every other consideration to the prevention of future wars. This crescendo of destructiveness can well be fatal to civilization. Acres of gas-filled rockets, poised and aimed to distant cities, can only be stopped by preventing their production and installation.

DC-4 Transport through the Ages, to date (12)

We must stress this tendency of modern war towards total destruction—a truly vicious spiral insofar as progress of civilization is concerned; and again we must appraise our ability to master ourselves in using the types of weapons which we now have available. Locating our factories underground and possibly moving many more activities similarly can only be looked upon as a retrogression and probably an ineffective measure. In this regard, although dealt with later more extensively, I would like to introduce here the conception of the tremendous difference between war and policing; the one for destruction to attain national ends, the other to maintain order and achieve security for all.

It is appropriate to stress the fact that warfare has changed from a conflict between the armed forces to total war which encompasses whole populations, both as targets and as producers of weapons. Possibly this can be best illustrated by indicating the extent of our aircraft production programme in the United States. For this purpose, there are shown two curves, Figure 1 indicating graphically the output from July, 1940, to the present time in terms of airframe weight, airframe employees, and resultant efficiency, as pounds per employee per month.

On Figure 2 is shown the climb in output during the same period, repeating the airframe weight curve and adding the story on engine horsepower and number of airplanes. The magnitude of the effort is also depicted in terms of increase in airframe weight. Compared to July, 1940 production, the war period shows a 4,500% increase! The 3-fold increase in the average size of aircraft

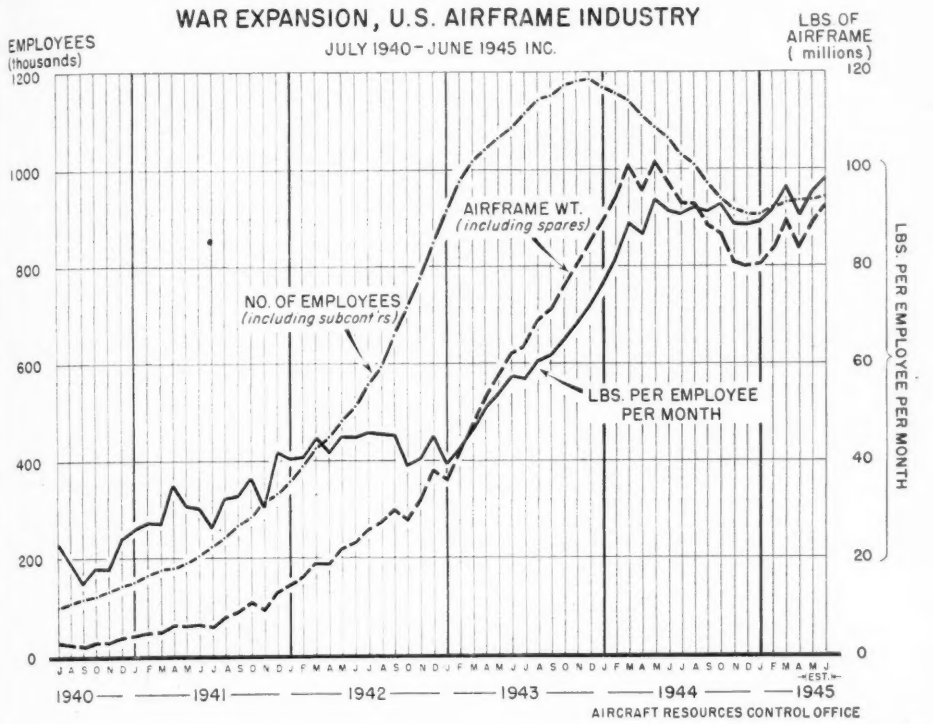

WAR EXPANSION, U.S. AIRFRAME INDUSTRY
JULY 1940 – JUNE 1945 INC.
EMPLOYEES (thousands)
LBS OF AIRFRAME (millions)
LBS. PER EMPLOYEE PER MONTH
AIRFRAME WT. (including spares)
NO. OF EMPLOYEES (including subcont'rs)
LBS. PER EMPLOYEE PER MONTH
1200
1000
800
600
400
200
0
120
100
80
60
40
20
0
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
EST.
1940 — 1941 — 1942 — 1943 — 1944 — 1945
AIRCRAFT RESOURCES CONTROL OFFICE

FIG. 1

during the period is of interest. In round numbers, the annual aircraft deliveries in the U.S., starting with 1940, were 6,000; 19,000; 48,000; 86,000, and finally in 1944, 96,000. But because of this increase in average size, the yearly output in terms of airframe weight increased from 21 million pounds in 1940, to 1.1 billion in 1944—over 50-fold.

Let us appraise this increase and its present status in terms of overall national economy. Here we find that the manufacture of aircraft (completely applied to the waging of war) has, in the United States, attained a relation, when compared to total munitions output, of 27%; to total manufacturing output of all kinds, of 20%; to total national income, of 10%. These facts, considered in conjunction with the deficiencies in manpower present in all countries and the very high percentage of female employees in war factories, stress the total character of modern warfare. Even in peace times upward trend of costs for military preparation could but be viewed with alarm. In the axis states in the 1930's it approximated 25% of national income.

Economic efficiency in terms of war is economic inefficiency in terms of public welfare! The per capita cost of war has increased tremendously, even since World War I. It now costs over 50,000 dollars to kill one German or Jap. To kill each enemy soldier it cost Napoleon but 3,000 dollars, and Cæsar 75 cents! And there is no glamour in war. Well do I remember when visiting General Doolittle's Eighth Army Air Force headquarters last year that his first display was a gallery of pictures showing planes going down in flames or in pieces—our planes.

Of great significance, however, from our present point of view, is the development of air transport during the war. Although

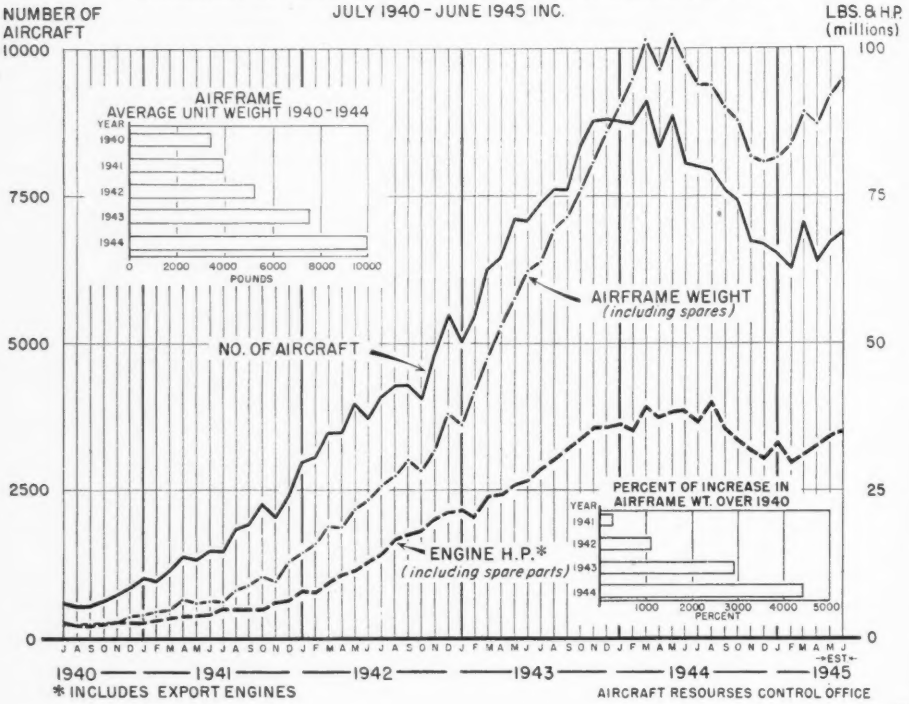

NUMBER OF AIRCRAFT, AIRFRAME WT. & ENGINE H.P.*
JULY 1940 - JUNE 1945 INC.
NUMBER OF AIRCRAFT
LBS. & H.P. (millions)
10000
7500
5000
2500
0
100
75
50
25
0
AIRFRAME AVERAGE UNIT WEIGHT 1940-1944
YEAR
1940
1941
1942
1943
1944
0 2000 4000 6000 8000 10000
POUNDS
AIRFRAME WEIGHT (including spares)
NO. OF AIRCRAFT
ENGINE H.P.* (including spare parts)
PERCENT OF INCREASE IN AIRFRAME WT. OVER 1940
YEAR
1941
1942
1943
1944
1000 2000 3000 4000 5000
PERCENT
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
→EST←
1940 1941 1942 1943 1944 1945
* INCLUDES EXPORT ENGINES
AIRCRAFT RESOURSES CONTROL OFFICE

FIG. 2

its importance was little appreciated by us at the outset, its relative contribution to the war effort has increased by leaps and bounds since 1942. The transport plane has served many purposes, such as carrying of troops or paratroops, the towing of gliders, evacuation of wounded, transportation of officials and the establishment of important communications both over land and sea. In the Pacific war particularly, it has served as the work horse of the other services, transporting materials for the construction of air field, carrying food to isolated troops, carrying spare parts and even machines of large size, and performing every possible type of service in the island warfare. Progress could not have been so rapid as it has been by a wide margin without the air transport planes which have been made available during the last three years.

It should be noted that, with the exception of the specific military character of some of its cargoes, all uses developed during the war for the air transport plane will have direct application to peace-time functions.

GOVERNMENT AND CIVIL AVIATION.

Government may have three functions to perform with respect to any new development such as aviation: promotion, regulation or operation. It may be of interest to this audience to be reminded of the type of government participation in civil aviation which exists in the United States under the Civil Aeronautics Act of 1938. Under this law as modified by subsequent executive rearrangement, there have been established two main civilian agencies dealing with the air; namely the Civil Aeronautics Board and the Civil Aeronautics Administration.

The functions of the former are for the most part regulatory, dealing with the economic phases of air transportation, including airline business relationships, and especially concerned with the rendering of decisions as to when new air carrier enterprises can properly be established from the standpoint of public convenience and necessity. When an airline decides that it can economically establish an extension to its existing routes, or when a new enterprise wishes to enter the field, in either event it must present its case to the Board before operations can start. Public hearings are then held to bring out evidence on which the Board can base its decision on the propriety of inaugurating the operations. Another function of the Board is more legislative in character in that it involves the formulation of the Civil Air Regulations, which cover all phases of aviation, divided into the following groups and sections: Aircraft, subdivided into airworthiness of the airplane, engine, propeller, equipment and radio, and with maintenance for each; Airmen, including certification requirements for pilots, mechanics, traffic controllers and airmen physical standards in general; Air Carrier Operating Certificates; Air Agencies, including flying and mechanics schools and repair stations; Air Navigation, subdivided into air traffic rules, scheduled air carrier rules and foreign air carrier rules; and finally a section on definitions. Two final functions, judicial in character, involve the determination of violations of Regulations and penalties which should be imposed in case of appeal; and the investigation of accidents.

In connection with the economic function, it should be noted that insofar as domestic air carriers are concerned, subsidy of operations has largely disappeared. In the 10% of instances where anything resembling subsidy still exists, it is supplied only through the medium of special payment for the carriage of mail. It is a subsidy to the public receiving the benefits of a service still marginal from the economic standpoint.

During the first 25 years of domestic air mail service, the postal revenues were less than the total expenditures paid out by the Government, including direct payments to the airlines for carrying the mail plus indirect Post Office Department costs apportioned to the air mail account. Then in 1943 the condition reversed and a substantial profit was shown. This has increased subsequently to such extent that during the first half of 1945, about now, in fact, the cumulative deficit of the first 25 years has been offset completely by recent profits. This is a condition confidently anticipated as one likely to continue each year after the war.

In the field of foreign air mail service, this healthy condition has not yet been reached, though the trend is definitely in the right direction.

A corollary of this trend is the possibility of eventual elimination of the air mail surcharge, an action which would substantially increase mail loads, as under such condition all mail would be transported by whatever means would be most rapid, decision being made by the Post Office Department officials; another benevolent spiral!

The Board does not control the frequency of air carrier schedules, once new routes have been authorised on the basis of public convenience and necessity. They do, however, as stated above, control the mail payment rates, and therefore profits in general. Their objective is to establish the lowest rate compatible with economic health, which implies need for profitable operations. Otherwise stated, their object is to hold charges to the public, the consumer, to a minimum. Therefore, should the profits of an air carrier appear to be unreasonably high, the Board may call for new hearings to ascertain airline justification for retention of existing rates as against public need for a reduction in rates for the carriage of mail, passengers or cargo.

The Civil Aeronautics Administration, on the other hand, as its name implies, is executive in character, although within its jurisdiction are certain phases coming under

all three of the functions first named; i.e. promotion, regulation and operation. Fundamentally, however, its whole raison d'etre is summed up in the directive it has received from Congress " to encourage and foster the development of civil aeronautics and air commerce in the United States and abroad." This promotional aspect is currently applied to the development of airports, to training and education, to the preparation and dissemination of information and statistics dealing with aviation, and to participation in activities involving the furnishing of assistance to foreign countries.

From the standpoint of regulations, this agency has the job of enforcing the Civil Air Regulations that the Board has enacted, dealing with aircraft, airmen and air carrier operations. Its only actual operating function, which, however, is its largest activity from the standpoint of personnel, is the operation of the federal airways. Here it establishes, maintains and operates all aids to air navigation which form part of the federal airways system. Included, of course, are the radio ranges, beacons and emergency fields. It also handles air traffic control operations at airport towers and traffic control centres and performs the ground communications functions of disseminating weather and other types of information.

The many functions of the Administration make necessary a decentralisation of its activities, with personnel located in all parts of the country, and many abroad. Policy and technical direction emanates from Washington with operations locally administered. The Civil Aeronautics Administration has a total force of just over 10,000 persons, of which 1,000 are in Washington. The Civil Aeronautics Board, on the other hand, has a total personnel strength of 330, all stationed at the Washington headquarters.

In carrying out its duty of " encouraging and fostering " aviation in the United States, it is the responsibility of the C.A.A. to prepare long-range programmes, anticipating the growth of aviation and the attendant needs for the installation of improved aids to air navigation. Here, indeed, is a difficult task when consideration is given to the rapid development of electronic devices occasioned by the war, which may almost overnight completely alter our conception of air traffic control and means of assuring air separation in general.

At the present time very great effort is being made by the C.A.A. to lay a proper foundation for a rapid, but sound development of private flying, the importance of which can scarcely be overestimated. The encouragement to the owner of the personal aircraft furnished by C.A.A. is incorporated in a four-plank programme:

First is the establishment of airports, particularly those of the smaller sizes adapted for use of the private flyer. At present the airports in the United States total about 3,000. The Federal aid airport programme which we have suggested to the Congress for consideration envisages an increase to 6,000. Over 80% of the increase will be in the smaller Class I and II airports. The programme is so planned as to place airports at relatively uniform distances and in sufficient numbers in communities as to make private flying really practicable, as is the case with the automobile driver who has surfaced roads available for his use.

The second point is to examine existing regulations and their effect on private flying, with view to making recommendations to the Board covering changes which will, to the maximum extent possible commensurate with public safety, relax requirements and make it easier to obtain a pilot certificate and otherwise enhance the attractiveness of personal aircraft ownership and operation.

The third point is the encouragement of aeronautical education and pilot training. It is hoped again to establish a Federal aid pilot training programme which, in company with the high school educational work that is being established, will make

the coming generation universally air minded.

The final plank in the programme is the development of the personal aircraft itself, which, although it will be carried out in detail by the aircraft manufacturing industry, will be fostered and aided by the C.A.A. It is believed necessary in order to attain our present goal consisting of a registered total of 400,000 planes ten years hence, that the personal aircraft must be considerably improved in a number of respects. Its price must be reduced, its safety enhanced, its utility increased by means of improved performance, and several features added which will make it in general more attractive. Here I refer particularly to such improvements as the decrease in noise, making flying more pleasant not only for the occupants of the plane, but for the residents living adjacent to the air-parks, which, under our airport programme, must, we feel, be located within residential sections if they are to serve their proper purpose. Another feature in the development of the airplane itself is the further development of the undercarriage, possibly along the lines of the Maclaren gear developed in England, which will make cross-wind landings safe and practicable.

It is the hope of those of us involved in carrying through this programme that we may contribute towards meeting the overshadowing need of our generation for intelligently organising government operations dedicated to the advancement of the common good—in this case, aviation. In this highly specialised age it is particularly necessary that government co-operation be extended in such fields, as the average man cannot possibly keep abreast of the rapidity of technical advances.

TECHNICAL DEVELOPMENT.

Advances in technical development and plans for the use of improved equipment must constantly move in parallel; and as technical development takes time, it is necessary in long-range estimates always to evaluate the revised equipment before it is actually ready for use or even finally proved practicable. In this regard, it must be appreciated that as the physical sciences advance, development is analogous to a regenerative furnace, feeding upon itself and ever accelerating. It is always a mistake in planning an operation or a use not to take these factors into account and not to assume in advance improvements concerning which in many cases the hard-headed engineer will only shake his head.

Another point to note is the co-operative nature of development, contributions coming from many people in many nations. This was amply evident to me during my trips to England during the war, when a slightly different point of view which had gained ascendancy in your country led to long trains of fruitful speculation on developments which we were considering or had undertaken.

Whereas we, I believe, had something of importance to contribute in our common cause in line production, of turbo supercharging and pressure cabins, of laminar flow wings, precision bombsights and types of naval aircraft; you, in turn, showed great foresight on many scientific applications and design innovations, starting out with your early appreciation of the value of the multigun fighter and of the power-operated turret, and then such developments as the gyrostabilised gun sight, bubble canopy, sleeve valve engine and automatic controls, and finally the gas turbine and jet power plant. To the Soviet Union we must ascribe the original conception of the potential importance of paratroops, and to Germany the development and use of the glider, the buzz bomb and the rocket. So, too, in a world concerning itself with the advancement of civilization, there will be need for the national characteristics and aptitudes of all people to supplement the individual effort of a par-

ticular state, if optimum progress is to be achieved.

It is important that we use this vast reservoir of knowledge acquired during the war for advancing the general welfare thereafter. Through intensification of research and implementation of technical education, and with the groundwork in technical development in aviation which we now inherit, we are, I believe, on the threshold of the greatest period of aeronautical development that has yet been witnessed. To mention but a few items which may revolutionise development I would cite: the gas turbine and jet power plant, which will increase in efficiency as aircraft speeds go up, thus making aerodynamic development a limiting factor in speeds to be attained as distinguished from the piston engine power plant limitations (including the propeller) already reached at speeds of 475 m.p.h.; laminar flow wings; the development of structural designs suitable for such wing shapes, especially in thin sections, necessary to surmount our next barrier—compressibility. Our greatest effort from the research standpoint in the next period of time will be the investigation of aerodynamic phenomena at supersonic speeds. Possibly we have far to go before transcending the speed of sound, but the rapidity of present development indicates that this may be accomplished in the not too distant future. It is of interest to note that, having passed the speed of sound, there is some reduction in drag coefficient.

Developments of comparable magnitude and of equal importance to aviation are to be found in the electronic field. Electronic devices which will make all-weather operations safe and practicable are already in the offing and further developments, probably using Radar, will make air traffic control a matter of individual separation as on the roads rather than by ground instruction and control. Each pilot will do his own flying, so to speak, his own instrument weather navigating, determining from his instrument board " screen " his proximity to others.

Then there is the helicopter (only just getting itself off the front pages of popular magazines), which will experience an intensive development which bids fair to make it a popular private plane of the future. It will supplement the air transport plane as the automobile does the railroad. There are, of course, possibilities, of combinations of rotating and fixed-wing aircraft, which may achieve both low landing speed and high cruising speed, not apparently attainable by the helicopter itself.

Accompanying these technical developments is the need for simplifying operation of the aircraft and reducing costs, particularly in the private-owner field, so as to make possible the tremendous expansion there which many envisage.

Again I express it as my belief that the technical development of aviation will be greater in the next ten years than in the past, and that we must foresee and anticipate this development to a considerable extent in order properly to evaluate the fields of usefulness of aviation in the future.

FIELDS OF USEFULNESS FOR AIRCRAFT.

Let us appraise several fields of human relations to determine where aircraft can contribute positively to progress; to learn the place of aviation in civilization. All of the fields selected here, and there are undoubtedly others, are to some extent interdependent and overlapping, but the samples given should clearly expose the possibilities.

Economic Uses

This science treats of the production, preservation and distribution of wealth. Each of these involves employment, which has prompted me to prepare a forecast to indicate how many jobs aviation should provide in one country, the United States. The attached table, Figure 3, provides an estimate for a period eight to twelve years

after the war. Though even in a decade there is a great drop in employment from war-time peaks, there still appears to be a really important contribution to peace-time economy indicated, with more than twelve times the number of persons employed in aviation as were so engaged just prior to the war. The figures of the table include so-called "grass roots" employment, that is, jobs outside the aircraft industry, such as are involved in mining, fabricating and otherwise preparing the materials used in aircraft construction, supplying tools for aircraft factories and other similar services.

UNITED STATES EMPLOYMENT—
DERIVED FROM AVIATION

A FORECAST—8-12 YEARS AFTER THE WAR

Manufacturing—(*1)		
Personal Aircraft	100,000	
Transport Aircraft	25,000	
Total	———	125,000
Military		210,000
Total Manufacturing		335,000
Air Transportation—(*2)		
Scheduled (Domestic)	115,000	
Scheduled (International)	30,000	
Non-scheduled	30,000	
Total	———	175,000
Service Industry		80,000
Government		20,000
Total Air Transportation		275,000
Grand Total—(*3)		610,000 (*4)

*1—Includes "Grass Roots" Employment at 33 per cent. of total.
*2—Includes "Grass Roots" Employment at 20 per cent. of total.
*3—The Money Value of the Products and Services given are just under three billion dollars.
*4—Pre-war Employment was 50,000; War-time peak, excluding Uniformed Personnel, 2,750,000.

Fig. 3

The fundamental concept of economics is production and consumption, supply and demand. Between the two is distribution, the function in which air transport will find its greatest usefulness. This service, though economic in character, is therefore dignified by treatment under a separate heading. Another important function entering into business relationships is communications, as distinguished from transportation. This also is treated later on.

There are a great many direct services which the airplane can render that will find their places in our economic life of the future, and, of course, the list will be supplemented by many others which have not even occurred to us as yet.

First there is so-called taxi service, which may be used extensively in transporting persons and goods from small communities to main stops of trunk lines. Many feel that this form of transportation may be found more economical and therefore more extensively used than small feeder-line services operating on a scheduled basis.

Then there are a great number of charter services for which the airplane is admirably adapted, such as crop dusting and insecticide spraying, aerial planting, spotting services of various natures, such as fire, oil line breakage and fish locations; equipment dropping to furnish needs of persons or communities in isolated locations; and aerial photography, serving a multitude of uses, such as the laying out of golf courses, estates and communities; and preparation of maps useful in crop planting, soil conservation and flood control.

There are also the obvious services pertaining to aviation itself, such as pilot training and aircraft maintenance and servicing.

One of the most promising uses of the airplane and the one most important from the standpoint of world economics is foreign commerce. When the airplane finds its proper place in this field, and when confidence in the hoped-for world security organization is established, there will be no need for the uneconomical measures of self-sufficiency which are so paramount in the minds of many at this time. The interdependence of nations in our machine age is becoming more and more apparent. For

example, an automobile manufactured in the United States uses materials normally obtained from nine locations in widely-scattered sections of the world. Even a telephone requires materials from seven. This all points towards the economic unity of the world.

There is, furthermore, the influence of world-wide use of the airplane upon geographic division of labour, so that people in all parts of the world can perform the services for which they are the best adapted from the standpoint of skills, climate or proximity to labour or material sources. We thus see that ultimately political unity rests upon rapid means of transportation and communication. Here the airplane's greatest contribution can be expected.

The above outline, though brief, furnishes an indication of the extremely important place that air transportation will play in the future of our economic life as individuals, as communities, as states—all part of a larger world community.

Transportation

Obviously, transportation is part of the general economic structure, and the place in which the airplane can play a basic role. Speed of transportation represents a yardstick for the progress of civilisation. This speed may, perhaps, in the immediate future allow us so to accelerate the tempo of commerce and industry as to catch up economically and socially with the time lost and the material destruction of the war. The tremendous activities of air transport services in the conduct of the war are readily susceptible to transfer to uses essential to rehabilitation and readjustment, involving the transportation of food, medicines and people.

The prospect of such major contribution is emphasised by the existing trans-Atlantic flying, amounting to a four-engine plane flying one way or the other each fifteen minutes in the service of the U.S. Air Transport Command alone. Any medium of transportation which finds geographic conditions no barrier must become of major importance.

The factor of speed, which, in addition to independence of ground or water barriers, is the most important contribution the air carrier has to make to transportation, must in itself be reckoned with when forecasting increase in air traffic in the future. It is not appropriate merely to extrapolate past performance in order to determine future achievement. Whereas within the aviation industry in comparing individual airplanes, a formula of efficiency such as cruising speed multiplied by pay load and divided by some function of cost is appropriate, it is believed that when comparing different media of transportation with different orders of speed in connection with prognostications of future traffic, it is necessary to give further weight to this speed factor possibly by raising the cruising speed term to the second power. The advantages of air transport will engender additional traffic not possible without the presence of the greater time-saving involved when travelling by air. (From the engineering standpoint computations have shown that it is well worth while to increase the cost of a given transport plane by well over 1,000 dollars, if by so doing its cruising speed can be increased one m.p.h.) The increase in air traffic will not, it should be stated, be at the general expense of other means of transportation. The whole tempo will be so raised as to carry along with it added traffic best suited for transportation by rail or steamship, although the relative proportions of types of cargo carried thereon may be substantially altered.

On the accompanying graphs are shown trend curves indicating U.S. air transport statistics for the ten years prior to the war, with extrapolations estimated for the next decade. Although statistics for war years are given, these, obviously, must be discounted, as traffic was abnormally large and equipment greatly reduced. Revenue passenger load factors which had stabilised at about 60% just before the war rose to about 90% during the war period and are expected,

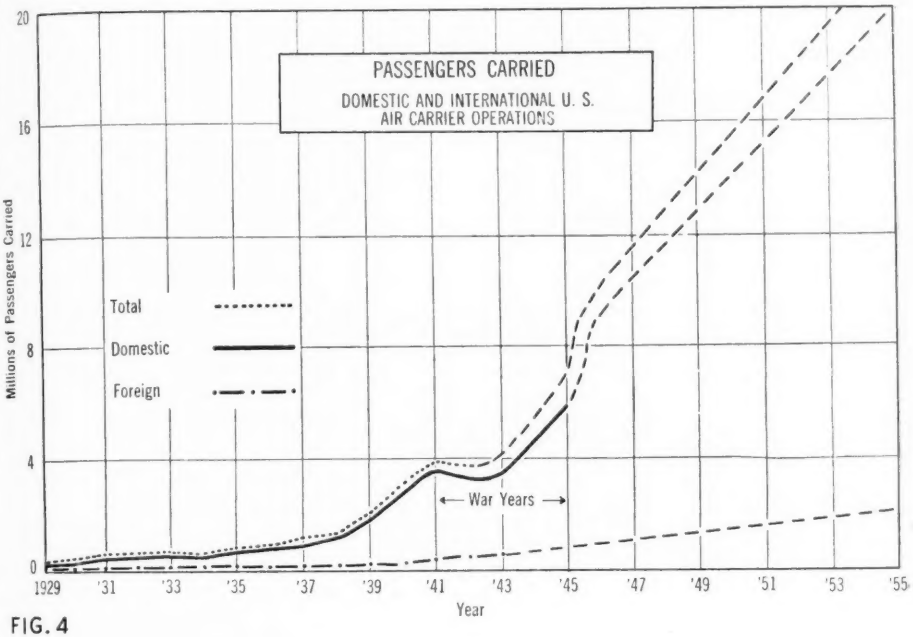

PASSENGERS CARRIED
DOMESTIC AND INTERNATIONAL U. S.
AIR CARRIER OPERATIONS
Millions of Passengers Carried
20
16
12
8
4
0
Total
Domestic
Foreign
War Years
1929
'31
'33
'35
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 4

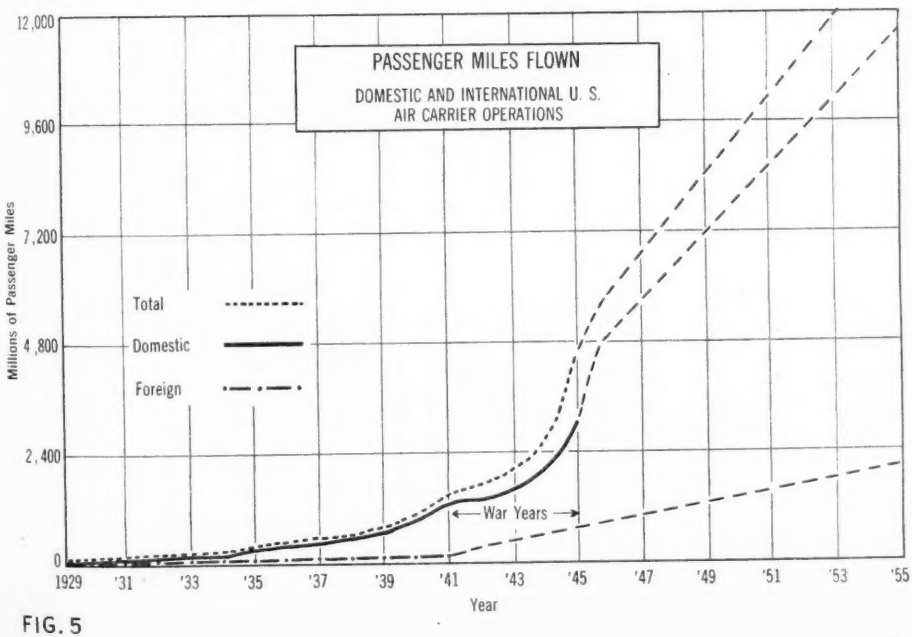

PASSENGER MILES FLOWN
DOMESTIC AND INTERNATIONAL U. S.
AIR CARRIER OPERATIONS
Millions of Passenger Miles
12,000
9,600
7,200
4,800
2,400
0
Total
Domestic
Foreign
War Years
1929
'31
'33
'35
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 5

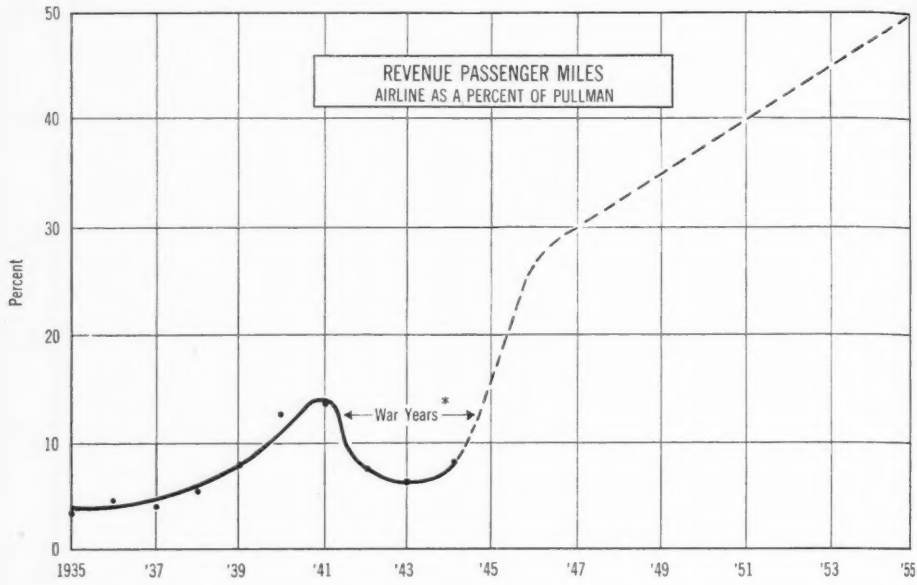

REVENUE PASSENGER MILES
AIRLINE AS A PERCENT OF PULLMAN
Percent
50
40
30
20
10
0
War Years
*
1935
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 6

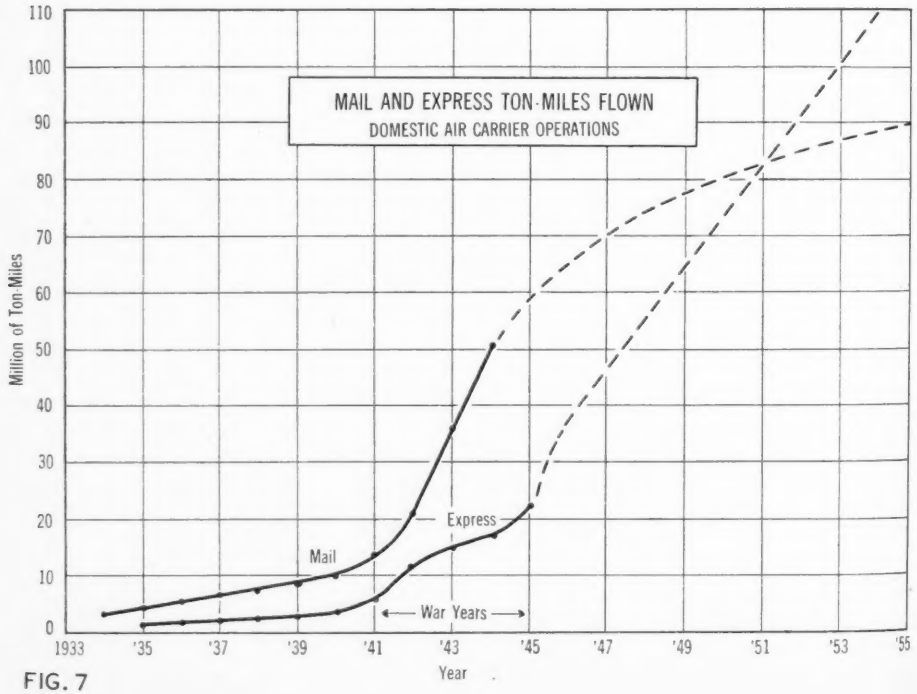

MAIL AND EXPRESS TON-MILES FLOWN
DOMESTIC AIR CARRIER OPERATIONS
Million of Ton Miles
110
100
90
80
70
60
50
40
30
20
10
0
Express
Mail
War Years
1933
'35
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 7

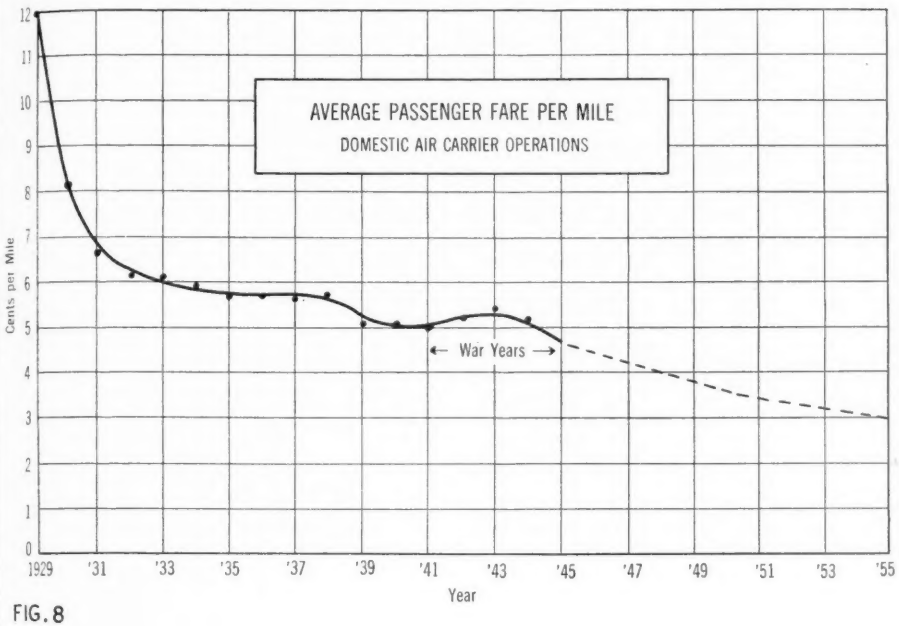

AVERAGE PASSENGER FARE PER MILE
DOMESTIC AIR CARRIER OPERATIONS
Cents per Mile
0
1
2
3
4
5
6
7
8
9
10
11
12
← War Years →
1929
'31
'33
'35
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 8

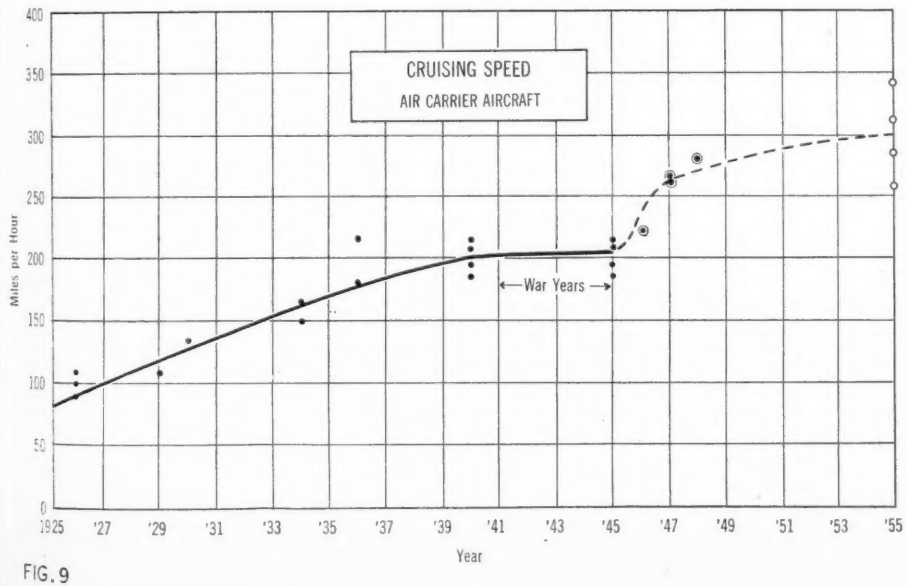

CRUISING SPEED
AIR CARRIER AIRCRAFT
Miles per Hour
0
50
100
150
200
250
300
350
400
← War Years →
1925
'27
'29
'31
'33
'35
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 9

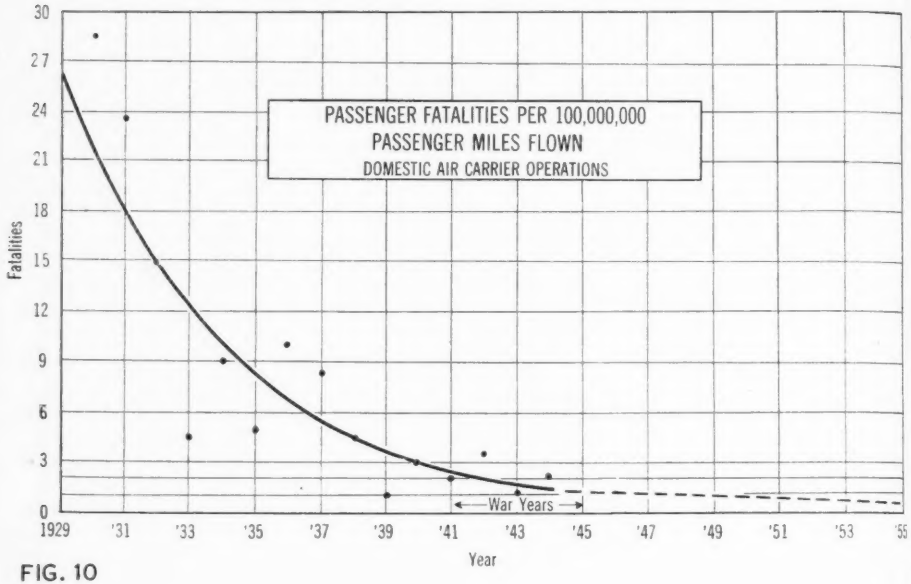

PASSENGER FATALITIES PER 100,000,000
PASSENGER MILES FLOWN
DOMESTIC AIR CARRIER OPERATIONS
Fatalities
30
27
24
21
18
15
12
9
6
3
0
War Years
1929
'31
'33
'35
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 10

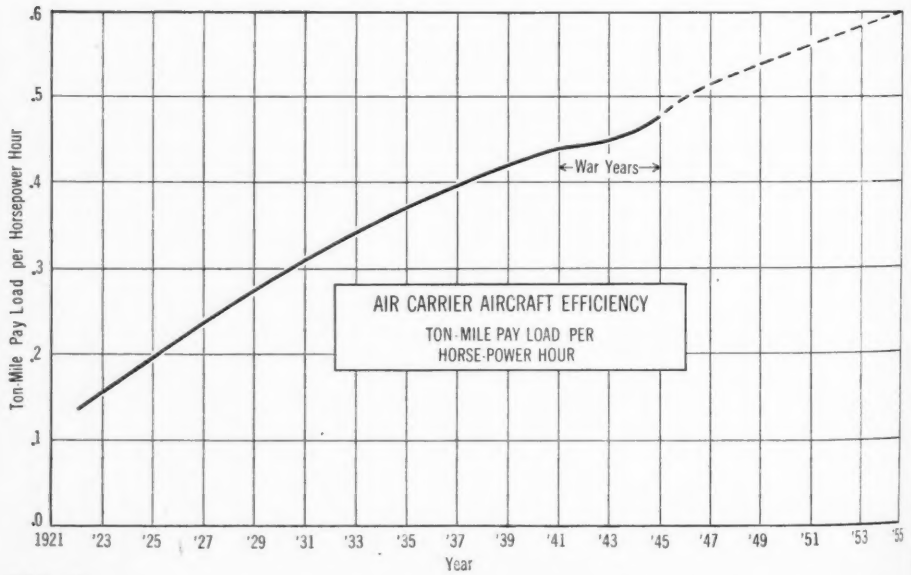

AIR CARRIER AIRCRAFT EFFICIENCY
TON-MILE PAY LOAD PER
HORSE-POWER HOUR
Ton-Mile Pay Load per Horsepower Hour
.6
.5
.4
.3
.2
.1
.0
War Years
1921
'23
'25
'27
'29
'31
'33
'35
'37
'39
'41
'43
'45
'47
'49
'51
'53
'55
Year

FIG. 11

after the peace is restored, to become re-established at about 65%. Average length of trip for passengers on U.S. domestic airlines before the war was about 400 miles.

Figure 4 gives passengers carried by U.S. domestic and international air carriers and shows prospect of transporting about 20 million per year by 1955. Figure 5 indicates an increase in passenger miles, 1 billion in 1940 to 12 billion in 1955. An interesting trend of airline passenger miles compared to Pullman is given in Figure 6. It is estimated that the pre-war 10% will increase to 50% in the next decade. Statistics relating to mail and express are shown in Figure 7. The anticipated acceleration in express traffic which will equal mail tonnage by 1951 is emphasised as an indication of the decreasing importance of the mail subsidy in air carrier economics.

The passenger fare trend is given in Figure 8. The present 5-cents per mile tariff should drop to 3-cents in ten years. Forecasting cruising speeds is somewhat of a risk because of the tremendous developments anticipated and previously described. Yet a trend curve bringing these speeds to 300 miles per hour on the average by 1955, as given on Figure 9, are certainly reasonably sure of attainment and admittedly will be exceeded in many specific instances. On Figure 10 statistics indicative of improvement in safety are given in terms of passenger fatalities per 100 million passenger miles flown. This rate at 1 per 100 million is hoped for soon, with losses at less than this number the rule after 1950. Finally, on Figure 11 the trend in operating efficiency is shown. Improvement is directly proportional to ton mile capacity, pay load per horsepower hour. Substantial and continuous improvement is anticipated.

One may ask, however, "What of the prospect of cost reductions of such magnitude as to bring air travel within the reach of the masses of population?" The trend of statistical information as given above is reassuring in this regard. Whereas for domestic air transport operations in the United States in the 1920's costs on a capacity load basis were of the order of 50-cents per ton mile, these had by the end of the 1930's decreased to 30-cents per ton mile, and may, on the basis of civil transport planes now used by the military service, soon after the war drop to figures of the order of 20-cents per ton mile for passenger carrying, and 10-cents or 12-cents for carriers of cargo only. It would therefore appear reasonable, and has, in fact, been estimated, that during the 1950's we may look forward to cost for passenger carriage on a capacity load basis of the order of 15-cents and for cargo of 8-cents or 9-cents per ton mile.

When these figures are translated into fares and tariffs by considering load factors of 65% or 70% and reasonable profits, it would appear justifiable to expect that during the 1950's passenger air transportation charge of 2½-cents per mile are within the realm of possibility, with express air transportation at rates of the order of 15-cents per ton mile, thus comparing favourably with rail travel without taking due account of other very real savings (salary, meals, etc.) attendant to reducing in-transit travel time. Certainly passenger travel at 3-cents per passenger mile and express transportation at 20-cents per ton mile is assured.

Forecasting over ocean travel rates is difficult unless specific trips are taken into consideration in order that the factor of range so detrimental to cost economy may be accounted for. Recent investigators have indicated the possibility of round trips to England from the United States at figures of the order of 200 dollars, or 3-cents per passenger mile, and several companies in the United States have actually forecast and published rates not greatly exceeding those figures. I believe these are somewhat optimistic. But even at some increase from this to such a round-trip cost as 300 dollars, which is certainly attainable, over-ocean travel may well approach the almost astronomical figures that some authorities have recently predicted.

Although it is probable that air transport will be utilised for the carrying of passengers, mail and express for the most part, there are possibilities for carrying freight, although probably not commodities of a bulk nature, i.e. those of low value per ton. The greatest potential here lies in supplying the needs of backward and under-developed regions where other means of transportation may take weeks or months as compared to hours when carried by air.

It is anticipated that carrying of express will advance by leaps and bounds after the war. Whereas at present the proportion of load carried by the domestic airlines of the United States is 75% for passengers, 17% for mail and 6% for express (with 2% for other uses), it is reckoned that the percentage for express will increase to a point where it will approximate that devoted to mail, even though the latter should itself be substantially increased by virtue of the probable eventual removal of any mail tariff surcharge. For over-ocean traffic the percentage devoted to mail before the war considerably exceeded that for passengers. It is believed possible that this disparity may lessen after the war.

Consideration should be given to the factor of population mobility, and I will close this section with a brief reference to the private plane or the personal aircraft. In evaluating the effect which such planes may have on city planning, full account must be taken of the tremendous change in our way of life which will be occasioned by the roof-top landings to which reference is frequently made, though its significance is seldom fully appreciated. If the helicopter should come into its own, as many expect, so that real masses of people could be moved to their places of business from their residences by air, the situation of road congestion would be so altered as substantially to affect the whole architectural arrangement of our cities. Also the possibilities of locating residence sections further from metropolitan business centres open vast vistas for the city planners. Recreational possibilities will be greatly enhanced by this greater mobility.

Communications

Communications are now dependent upon mail, telephone, telegraph and radio. Movement of persons by slower means such as rail and boat has very properly been considered as transportation rather than communications. Now, however, with Europe and America 15 hours or so apart, and with any part of the world 50 or 60 hours from any other, it is believed proper to devote a special section of this lecture to the changed position which the airplane, considered as a communications medium, brings to bear. Now, personal communications over great distances become possible; business and international arrangements can be greatly expedited and meanings clarified thereby. For example, air passenger service over the Atlantic will enable American or British concerns to send their salesmen, engineers and executives to the other side of the ocean far more quickly and frequently when the need arises than heretofore. Moreover, they will now unhesitatingly go, whereas the time involved before, frequently prevented attaining the direct advantages which closer contact of foreign traders with the markets themselves, provide. In addition to transporting the business man himself, the more expeditious shipment of orders, acceptance papers, shipping documents, comprehensive credit advice, specifications, blue-prints, estimates and other like information will greatly speed up business relationships.

One further point worthy of consideration is the greater prospect of dissemination and migration of cultural forms. The spread of Western Civilisation in many of its forms to all parts of the world is a characteristic of the last hundred years. This was made possible by means of transportation far more rapid than any theretofore available. This further increase in speed due to air transportation will accentuate the prospect of making available to everyone the world over

the thinking and developments of everyone else.

Cultural Considerations

Concerning this difficult subject, we must be aware of the greater possibility of leisure which this speeding up of transportation can bring about. Agencies of government should work toward transforming this possibility to reality. It is true, of course, that leisure does not automatically produce culture; far from it It merely creates an opportunity for developing the arts and cultural aspects of life not available when so large a portion of time of the masses of people must of necessity be devoted to making a livelihood. It therefore is incumbent on other forces, notably education, to develop the desire on the part of those who have this increased leisure to use it effectively and for cultural purposes.

However, travel, which will certainly be greatly increased, has a broadening effect and should assist in enhancing the cultural life of a great segment of people.

One further point which I would like to make is the mere pleasure which flying can give. There are many millions of people who cannot appreciate the experience that they have ahead of them when they shall make their first flights. For many of us this pleasure in flying continues and increases with each trip. But here let us defer to Jan Struther:

> "How hopelessly people fail, Mrs. Miniver thought, when they try to describe flying to someone who has never done it. They leave out all the really important things. They tell you that it saves time and (taking everything into account) money; they tell you that it makes the earth look like a map, cows like ants, and cars like beetles. But they don't tell you that it is staggering, tremendous; that it is not merely an experience but a rebirth; that it gives you for the first time in your life the freedom of a new dimension (for although we know that there are three of them, we are forced to move mainly in two: so that our sense of up-and-downness is necessarily dim and undeveloped compared with our acute perception of the to-and-fro). They don't tell you that when you are up there it is the aeroplane that seems to be the safe solid core of things, while the earth is a distant planet upon which unfamiliar beings move among unthinkable dangers. They don't tell you, either, that you will be torn all the time between an immense arrogance and an immense humility, so that you are at one moment God and at the next a nameless sparrow. Nor do they tell you what it feels like to thread your way among the noble and exciting architecture of the clouds; nor how—best of all—you may suddenly find a rainbow arched across the tip of your wing, as though you had caught it in passing and carried it along with you."

The International Field

There are many fields of usefulness for aircraft in international affairs. The obvious function of facilitating commerce has been discussed. Also, reference has been made to the opportunity for alleviating economic pressures. It is important that we be aware that the airplane makes possible a greater availability of markets in any part of the world to any potential customer elsewhere. The trend toward self-sufficiency of nations is believed to be an important contributing factor towards the likelihood of war as it is also a consequence of that likelihood. The need of self sufficiency could be removed by collective security and international economic and monetary co-operation. All peoples would then be able to do the things for which they have the greatest aptitude. This should mean greater average production with attendant improvement in efficiency since a larger market will be available. The airplane underlines the importance of creating conditions

under which the military aspects of aviation will be minimised and its commercial aspects developed. It is important, therefore, that states should place a greater emphasis on the economic aspects of air transport than the political. Should the airplane become the tool of politics with prestige factors entering into policy determinations, its greatest usefulness will certainly be lost. Assuming acceptance of this concept, it is obvious that tariff barriers may be dropped, thus further facilitating world trade.

Another factor is the increase in living space and the relief of congestion which the advent of the air age may bring about. Many past wars have been caused by the fear, real or imaginary, of insufficient living space, and if the airplane can, as is believed possible, alleviate these fears, it will have performed a worth while mission.

All of these factors, particularly the first, should lead towards a general improvement in the world standard of living, a factor which also will be important in our search for the elimination of items which contribute to the likelihood of future wars.

In facilitating international relations the conference method has come to the fore both before the war and more particularly during it. This is believed to be a desirable tendency. We must establish the conference method as an international habit if frictions are to be removed at their inception. The role which the airplane can play in promoting and expediting international conferences is obvious. It has been proved at the several important meetings during the war, such as Casablanca, Teheran and Yalta. In this regard I might also mention the great part played in attaining reasonable success in developing technical annexes for international flying at Chicago. After that conference had started and the delegates became aware of the scope of the discussions planned, it became apparent that many important persons of several nationalities who were particularly competent to deal with these technical matters, had not made the trip to Chicago. These technicians were immediately summoned and within three or four days after the conference started were available so that the work could proceed effectively.

In all these ways, then, the airplane can be a very proper tool of peace; in facilitating conferences to remove frictions and promote international co-operation, and in permitting more effective international trade and division of labour that provide the whole world as a living space for every people. The airplane should "know no boundaries" and with this conception fully accepted, will be a tremendous force in cementing good international relations.

The acceptance of international agreements and participation in resulting associations must, to be effective, automatically entail the giving up of some rights heretofore considered as sovereign. Just as we are embarking on the conferences which it is hoped will result in a strong international organisation, an intensely nationalistic spirit is arising through the world. Of necessity war engenders such a trend. It must be appreciated, however, that this emphasis on nationalism and sovereign rights is inimical to the success of the new association of nations. The more appropriate tendency from the standpoint of future peace would be toward greater emphasis on a strong international body on the one hand and more secure individual rights on the other.

In truth we have been fighting for just these things—"To defend," according to the Declaration of the United Nations, "life, liberty, independence and religious freedom, and to preserve human rights and justice in their own lands as well as in other lands." On the other hand, everything in the Nazi philosophy has been in the opposite direction. The importance of the individual under Hitler's regime has been drastically reduced with view to making the state the supreme objective. Under such a creed it has been fundamental that man is for the state rather than the state for man. The Nazis have eliminated the dignity of man. The proper

idea is well expressed by Thomas Mann: "We must define democracy as that form of government and society which is inspired above every other with the feeling and consciousness of the dignity of man." The Nazi philosophy has, furthermore, pointed away from any association of nations striving for peaceful objectives. Such axis alliances as have been made have been centred on the ultimate achievement of complete predominance over the world by one or possibly two states. After winning the war to eliminate this point of view, it is of extreme importance that we so organise the United Nations as to assure the proper place and relationship of the individual, the state and the community of nations. World citizenship is a concept on which few have cared to dwell, but is one which must come into wider acceptance if a permanent peace is to be established. Certain basic human rights must be secured by the international organisation through the nations in which each citizen lives, and each individual must feel himself a citizen both of his nation and of the world.

THE INTERNATIONAL CIVIL AVIATION CONFERENCE AT CHICAGO

As Technical Secretary of the International Civil Aviation Conference at Chicago and so as an international public servant, I did not have the responsibilities of a delegate, and as a consequence was able to observe the meetings from a more detached point of view. Therefore, in an unofficial capacity, I can appropriately give my impressions of the meetings at Chicago and my opinions on its successes and shortcomings. In general, I feel that the conference needs the perspective of time to judge its accomplishments. Possibly too much was too hastily written about it in the Press of both our countries.

I would like to make it perfectly clear that in dealing here with the Chicago Conference and later in this lecture with the matter of collective security, I am speaking purely as an individual. I have, as is well known, long been interested in the field of international aviation organization and have for many years been an advocate of an international air police force. No lecture on aviation's place in civilization would be complete without substantial discussion of these vital subjects and I shall therefore give my views on both.

I emphasise that they are personal opinions and do not in any sense represent the present, or to my knowledge the prospective policy of the United States Government. In certain parts of these fields my associates in charge of policy in these matters have taken quite different positions from mine and in others policy has not yet been established. I am glad, however, to be able to state here my own views which I sincerely believe to be sound (and which my Government has no objection to my stating as my personal credo).

After the conference had been in session for a couple of weeks, it became apparent that there were two distinct points of view which would have to be reconciled if the conference were completely to achieve its ends. First there was what may be called the regulatory point of view. This aimed to stress the need for international co-operation in the establishment of controls over air transport, designed to prevent unfair competition or competitive practices sponsored by states in such a way as to jeopardise future amicable international relations, but with accompanying recognition of the world-wide need for air transportation services. This group considered international aviation rather more from the political point of view than the economic.

The other point of view may best be expressed by the term "maximum use." This group considered the expansion of air transport throughout the world of such fundamental importance and of such great value in itself as to make it desirable to achieve its most rapid possible growth. It felt such growth would best be promoted if the fewest possible controls were established. For many of the reasons heretofore enumerated,

this group felt that the inauguration and expansion of world air transport services in themselves will promote peace to such an extent as to make it worth while to risk slight international frictions now, if by so doing a free system can be obtained; one that will most rapidly expand due to normal competitive processes. The men supporting both points of view were honest in their opinions. It seemed to me at the time, and it seems to me today, that a compromise between the views of these groups was and is possible.

The first group, that is those who would like to make air transport dependent upon controls of a strong international body, felt that their system is necessary in order: to assure fair treatment for small nations having aspirations in aviation; to provide proper consideration to the present unfavourable standing in commercial aviation of several allied countries occasioned by the exigencies of the war; and to continue the organisation of world-wide air transport along the pattern of international collaboration agreed upon in the Atlantic Charter and at Dumbarton Oaks. They felt that the great importance of world flying should automatically indicate the need to place it under an international civil aviation body, having substantial regulatory powers in its own right, to insure its orderly development.

The expansionists, on the contrary, felt that any such restrictions and controls would so hamper the normal and proper expansion of air transportation as to offset any advantages which might be claimed for the international control point of view. In his thirty-first Wilbur Wright Memorial Lecture, Dr. Edward Warner included this oft-quoted passage:—

> "My hopes for the future are rooted in the . . . presumption that air transportation is a good thing; that the need of the whole world to share in its benefits should be a prime consideration in the planning of air routes; and that there shall be no return to those evil days when air transport was regarded with such caution and suspicion that it had to be administered in paltry and carefully-measured doses, with the authorization to operate internationally being parsimoniously doled out, schedule by schedule."

As the meetings progressed, the two points of view approached each other nearer and nearer until it seemed to me, and the view was shared by many others, that only a very little additional compromise was necessary on the part of either to attain the all-out agreement which was so greatly to be desired. It was incredible that the representatives of Allies that were currently fighting a common enemy on many fronts and in many cases under single command, could find matter for such bitter disagreement in the small spread of differences which still existed after the conference had been in session for about a month. The disagreements were finally reduced to the determination of a proper wording of a United Nations participation clause (over which, it seemed to me, there was very little difference of opinion), and to an acceptable clause dealing with the adjustment of capacity to traffic offering in regions beyond the first division point of through routes. This involved the now famous Fifth Freedom, and there again, were the relative importance of such through traffic to be properly evaluated, it seemed to me that agreement could have been reached. Actually, I am inclined to believe that accord was not reached partly because the conference had by that time already extended so much longer than had been anticipated that the very real factor of physical fatigue of delegates prevented agreement.

But in stating the opposing views and the fact that they were not entirely reconciled, one must not lose sight of the very real accomplishments of the conference. There was concluded an Interim Agreement on International Civil Aviation which establishes a Provisional Organisation that is to meet as soon as one-half of the nations represented at the conference (26 required) have signed

the document. It is ardently hoped that the first meeting of this organization will take place in Canada during the coming summer. Then there are two agreements drawn up as separate documents to be signed by those nations which might elect to grant the two freedom and five freedom privileges included respectively in each. These are known as the International Air Service Transit Agreement and the International Air Transport Agreement. Regrettable as it was that the two freedoms of the air (the privilege granted by a state to all others to fly across its territory without landing and the privilege to land for non-traffic purposes) were not made a part of the Interim Agreement and the Convention, it nevertheless is believed likely that so great a number of nations will ratify this document as to assure its later incorporation in the Convention. This is a tremendous step forward. Concerning it, Dr. Warner has recently written:

> "To realise what a landmark this is in aeronautical history one really needs to have lived with the subject during the years between the wars and to have seen at first hand how firmly almost every state has repulsed any attempt to release international transport from its cocoon of multiple national restrictions. . . . The participants to the transit agreement undertake to abstain from the role of feudal baron who levied private tribute on all the commerce passing along the highroads within his grasp."

In addition to the two freedoms described above, the International Air Transport Agreement adds three more privileges as follows:

(3) The privilege to put down passengers, mail and cargo taken on in the territory of the state whose nationality the aircraft possesses;

(4) The privilege to take on similar loads destined for the territory of the state whose nationality the aircraft possesses, and

(5) The privilege to take on passengers, mail and cargo destined for the territory of any other contracting state and the privilege to put down such loads coming from any such territory.

(Number 5 is the pick-up service clause.)

Then there was prepared a standard form which nations may use in making transport agreements bilaterally. This contains a large number of the provisions included in the Convention, thus setting a pattern in advance of the ratification of that document which will greatly facilitate the transition to its full effectiveness.

Then, finally, there is the Convention itself with its technical annexes, which is very complete and representative of substantial advancement from the 1919 Paris Convention, but which lacks those vital articles dealing with air transport and freedom of the air privileges discussed above.

Particular note should be taken of the excellent progress made in the technical annexes in establishing air navigation practices, rules of the air, and many others susceptible of standardization, such as airworthiness requirements for aircraft, meteorological protection, aeronautical maps and charts, customs procedures, and search and rescue. Most of these items are flexible in character, requiring change with the rapid advancement in the art. The agreement in the convention relating to the technical annexes was therefore one of collaboration rather than compulsion. In case a state should desire to depart from the international standard, it must notify the council of the extent of the differences from the standard and the reasons therefore. It must also indicate such departures on the certificates of airworthiness of its aircraft and the licenses of its pilots. It is then stipulated that "no aircraft or personnel having certificates or licenses so endorsed shall participate in international air navigation except with the permission of the state

or states whose territory is entered." The practice follows that utilised by most nations in automotive standardization, in which the advantages of adherence are so great as practically to prevent departure from them. At the same time, this method has provided a degree of flexibility in the event of future change which would not be present if rigid requirements for complete adherence and rigid rules for changing standards were so specified as to require formal ratification on each such occasion.

This, then, is what was gained in the conference, and it was much. Now let us appraise the unfinished business. It is significant that a resolution of the conference stressed the importance of proceeding immediately with further consideration of the omitted transport articles of the convention at the time the Provisional International Civil Aviation Organisation first meets. The work unfinished at Chicago, may therefore resume where it left off, with, I believe, every prospect of arriving at a successful compromise. There was, of course, some bad feeling engendered at the conference, which is to be deplored. It was, I believe, made more of in the Press than by the delegates, and should certainly not be over-emphasized to the extent that it has been. Only by the holding of conferences of this kind, achieving partial success and then renewing discussion at subsequent meetings for final attainment of the desired ends, can we acquire the habit of team work which is so essential in international dealings. Surely at the first meeting of the new organisation these transport clauses and matters involving rates and subsidies will be settled, a proper United Nations clause established, and an appropriate reconciliation effected between the views of those who consider world air transport as an essentially political matter on the one hand or as an economic one on the other. The present departure must not be allowed to act as an entering wedge between any of the United Nations, nor to drive countries into a more strictly nationalistic point of view, so inimical to world peace.

It is my personal opinion that the position taken by the British delegation in the final document suggested by them (in which are clauses dealing with the Fifth Freedom) represented a long step toward a solution and can, possibly, with very slight modification, be made the basis of final agreement. In brief, this point of view is the following: The aircraft of a state may fly from its own territory to its first major traffic stop in a foreign state (the first division of a through route) on the basis of an agreed upon allocation of traffic, subject to competitive frequency or capacity expansion thereafter determined by application of an escalator clause. Then for pick-up traffic on subsequent divisions, the Council of the International Civil Aviation Body shall have the power to determine what is fair and just. But in its deliberations it must give due consideration to four factors. This is important, and it is in this respect that I believe a solution may have been suggested by the British delegation that can be used as a basis for a final agreement. For one of the major criticisms of any general assignment of substantial economic control to an international body has been that it would have no fixed principles under which to operate. These governing criteria suggested by the U.K. are: (1) the capacity to which the state is entitled by virtue of its agreed allocation of the traffic flowing between its shores and the pick-up point; (2) the needs of that division for air transportation based on the economic determination of public convenience and necessity; (3) a fair and equitable appraisal of rights of states within the region for local airlines; and (4) an evaluation of the needs of traffic by an airline for that division in order that its through service operations may be conducted on a reasonably economic basis.

This plan provides the flexibility needed properly to make determinations as to what is fair in many different regional situations to which a standard formula could not possibly be evolved for universal application.

It is the writer's feeling that very little

restriction on important through-line operation would be occasioned by this procedure and that the alternative of completely wide-open competition might well result in injustices and in damage to amicable international relations to an extent out of all proportion to the expected gain in air transport expansion that might result.

It is possible that the divergence of opinion on the Fifth Freedom matter can be clarified further by discussing it from the standpoint of the difference in conception of government functions, heretofore stated as promotional, as compared to regulatory. The point of view of the expansionists as represented by the delegation of the United States would take the first position in this grouping—promotion. Those of the U.K. would come under the classification of regulation; and in the final classification of government functions, operation, would be the position of the delegates of Australia and New Zealand, who spoke eloquently for the internationalization of through-airline services. Possibly the greatest ovation of the conference was given to Mr. Sullivan, of New Zealand, and Mr. Drakeford, of Australia, when they presented the joint views of those commonwealths. Many persons present felt that the nature of air transport as a public utility is such as to make it desirable to internationalize world air-lines. And yet it is believed to be well recognized that without competition, efficiency will be lacking and the good of air transportation will not be afforded to so many regions or in so attractive a manner from the standpoint of optimum service to the public as would otherwise maintain. It is therefore the writer's feeling that the middle course of intelligent regulation of competing air-lines gives the proper solution. In short, competition is needed for efficiency. Where internationalization is indicated as desirable is in an international air police force. There competition is not desired, but collective security is. Briefly, economic efficiency requires competition—social progress depends on the absence of military competition.

It was quite frequently mentioned at the conference that the regulatory powers of the council were analogous to those possessed by the Civil Aeronautics Board in the United States. This is in a measure true, particularly insofar as the powers themselves are concerned. The analogy, however, is incorrect when consideration is given to the composition of the two bodies. Had it been possible in the deliberations in Chicago to have formed the council of persons selected only because of their own high qualifications, the analogy then would have been complete. Unfortunately, the council is to be composed of persons definitely representing the states from which they come, thus giving the council a political tinge which vitiates the analogy. It is possible that from the experience of the Provisional Organization and in some future revision of the international body established under the Convention, there can be evolved a different method of selecting members of the council so that all nations will, without political bias, feel justified in bowing to its decisions on purely economic matters.

But again let me emphasise that although the Chicago Conference resulted in incomplete documents, it nevertheless accomplished much of good and laid the groundwork for further deliberations. Improvements will be evolved, and in the meantime, world-wide air transportation will get started and expand.

A few remarks on the so-called "chosen instrument" policy appear in order. Although this is essentially a domestic matter for each state (as by any of the systems proposed at Chicago allotment of frequencies or quotas was on a national basis), it nevertheless does have a bearing on the tendency towards extreme nationalism, a malicious course if amicable international relations and world peace are desired. It might be a better policy for the Council, when giving consideration to air routes, whether new or expanded, to deal with companies rather than nations. Thus would the control of international civil aviation become even more

analogous to the Civil Aeronautics Board precedent and the tendency would be away from the intensely nationalistic point of view, which is in itself inimical to proper realization of the benefits of world organization.

COLLECTIVE SECURITY.

At Dumbarton Oaks the great powers reached a tentative agreement on a framework for a United Nations international security organization. The proposal encompassed subdivisions dealing with economic and social relationships, a secretariat, and a security council. Under the latter there is established a military staff committee. It is understood that during the conference deliberations, there were numerous proposals for varying types of military organization which would enforce the council's determinations, thereby supplying the factor most lacking in the League of Nations. It is understood that among these were suggestions to create an international police force. Although the final documents did not include such an establishment, they approached it by providing that "there should be held immediately available by the members of the organization national air force contingents for combined international enforcement action." It is possible that at the subsequent meeting at San Francisco, or at some other time, further consideration and final approval will be given to the development of this arrangement into an international air police force to carry out these functions.

The need of an efficient instrument to carry out the police function is self-evident. I have alluded to it at several points heretofore in this lecture. At the time the League of Nations was established after the last war, many deplored the absence of provision for such a policing agency. In the United States in 1914 I was proud to be a member of a prototype of the League of Nations known as the League to Enforce Peace. It emphasised this point. It has been well said that "justice without force is powerless, and force without justice is tyranny." The first clause is represented by the League of Nations, the last by Nazi Germany.

It cannot be expected, nor would it be desirable, for drastic reductions in armaments of the United Nations to be made, thus rendering each nation so weak as to be subject to attack, until such time as experience justified universal confidence in the World Security Organization. Gradual disarmament by individual nations thereafter could and should be made. Graphically, the curves depicting armaments (decreasing) and confidence (increasing) would cross. The advantages of disarmament are so obvious as not to require emphasis; for, indeed, should an effective international policing agency be formed, a country could expect to advance in the peaceful arts and in commerce and economic improvement in inverse proportion to the extent of its armaments.

Let us now consider in more detail an international air police force, a conception advocated by the French in 1932. It frequently occurs in engineering practice that some early discovery, discarded at the time, finds new life when the general advance in the art has made its application immediately important. Cases in point are the air-cooled engine cowling, the retractable landing gear, the controllable pitch propeller and the wing flap, all of which attained importance only when the overall aerodynamic cleanness of the airplane had improved to such an extent that their effect became of so great a magnitude as to counterbalance the increased weight and complication inherent in their installation. An analogy to this process can be made in the case of the airplane and its potential importance in establishing the success of a world security organisation. Attempts at inaugurating security organizations heretofore, culminating in the League of Nations, were not successful in performing the fundamental mission for which they were established, maintaining the peace of the world, because of the absence of a policing medium having the qualities essential to the job: certainly, speed, mobility and effective-

ness. Land and sea forces, alone, do not fulfill the requirements. But now with the airplane developed to its present stage, the world becomes of manageable size.

Before such a force can be effectively used, however, there must be a general-will-for-peace. This determination must be sufficiently strong so that there is a willingness to forego a limited amount of national sovereignty. Such limitations should include the right to make aggressive war; the right to judge a state's own cause in controversies with other states; the right arbitrarily to erect unduly burdensome commercial barriers; and the right to deprive its own subjects of the most fundamental human rights, such as freedom of speech, of the Press, and of religion.

Assuming, as we surely may, that the present aggressor states will be completely disarmed after this war, and that the international security organization is formed with adequate provision for the use of policing action, it would follow that disarmament could take place as confidence in the effectiveness of the police force would build up.

History indicates that there has always been a competition between offence and defence in warfare. The relative effectiveness of the one or the other has greatly influenced the time and spacing of wars. Occasionally, however, new weapons have been developed which have given such marked superiority to the offence as to bring about wholly new political conditions. As an example, the feudal system was centred around the defensive strength of the castle, with its battlements, moats and drawbridges. With the invention of gunpowder, the feudal castle was no longer impregnable, and a new political system grew up based on the small state as its unit. Then as states grew in size, a system of balance of power became prevalent, alliances being made which approximated balanced force potentials and resulted in considerable periods of peace. However, at intervals some power gained enough pre-eminence in arms that it risked war to gain regional or even world domination. This has resulted in two world wars in a generation.

The League of Nations without adequately organized force to sanction its decisions (and without the United States as a member) was ineffective in preventing the second World War. Now again an invention of such potency has been developed and perfected to such a point that it makes possible an improved social order based on a new political system. I submit that the United Nations Organization, implemented by a properly constituted international air police force, can accomplish what the League failed to do.

This police force might be composed of national contingents. However, such arrangement, without the establishment of agreed national maximum limits which experience indicates are impossible of enforcement, would indubitably lead to armament races, which in themselves will bring on new wars. At the opposite extreme, there might be a completely integrated international force consisting of all types of arms from each member state. This would be a very cumbersome organization and one most difficult to control. Then there might be a quota system, perhaps set up on a regional basis. A final possibility is a specialized international force, not large, but efficient, composed of the most mobile and speediest of the components of military action—the airplane. Under this conception, wherein there would exist an international air police force always ready for immediate use, national armies and navies would be available on call should the need arise. However, all nations should have an obligation to maintain their military contingents to some agreed minima, an assumption of responsibility desirable in establishing confidence in the security system as a whole. Limitation of armaments down to these minima will only occur (and it cannot be expected to be otherwise), when real confidence on the part of peoples and states has been established. Then, however, it will be

almost automatic and thereafter these minima can be gradually reduced.

Here it appears desirable to emphasize the differences between war and policing. These are threefold—first as to authority. Whereas no legal authority exists for war, a police force acts only to implement the enforcement of international law as interpreted by the international organization formed of the community of nations. War proceeds entirely from national authority. Second, there is the technique employed. In war, a national force acts under the direction of its own government, whereas a policing action is under control of a military staff responsible to the security council of the international organization. And finally, there is the difference in objective—war aiming at the military defeat of its enemy by each belligerent, whereas international policing aims at the maintenance of order under law throughout the community of nations.

Studies have been made to determine the practicability of establishing and operating an international air police force. These have shown the eminently satisfactory conditions that exist at the present time, wherein many island bases could be made available and could be used as the seat of operations for the contingents of such a force. It has been calculated that fifty bases throughout the world would be adequate in this regard and that a total force of some 50,000 planes, including training and cargo planes and the various combat types composing modern air forces, would be appropriate. For note, in civil society the uniformed police force is small in proportion to the population. The ultimate force behind law is the determination of the average citizen that law shall prevail. But without the police force, an ever-ready spearhead against crime, the citizens' determination is unavailing, and anarchy exists.

The financial upkeep of the force could be handled by the participating nations. It might be possible to introduce some form of taxation of individuals throughout the world to supplement the larger amounts contributed by states. This would give a desirable feeling of personal participation in the undertaking. The problems of procurement and supply are not impracticable or particularly difficult of solution.

A paramount consideration favouring an international air police force as opposed to national contingents, is the speed and mobility of the airplane. It is essential that enforcement methods keep pace with crime. This indicates the need for employing the most modern type of weapon in such an enforcement agency. It should be noted that in general, a law breaker will act only if immediate success appears likely. Distant disaster is not a deterrent. It is therefore essential in an international policing organization to have available a weapon that can strike with such speed and effectiveness as to deter a potential aggressor government from starting an operation. The restraint would be effective because even an immediate success is very unlikely.

So far the striking power of the airplane, presumably by bombing, has been emphasised. This is not, however, the only, nor possibly the most important contribution that the airplane has to make. Other effective uses would occur in the security council's functions of investigation, inspection, patrol and surveillance. Minor incidents at remote locations require immediate investigation. To send missions by any mode of travel where weeks pass before inquiry is commenced spells failure, as by then facts are obscured, or a minor incident will have become major. The ability of the security council to get investigators to the scene of trouble within a matter of hours may frequently make possible the immediate solution of the difficulty. To do this, two things are necessary: first, the availability of a transportation agency acting under the direct command of the council; and second, the availability to that transportation agency of aircraft to perform this function. Both are satisfied by an organization which includes an international air police force possessed of transport aircraft.

The inspection function used to assure compliance with the council's orders on such matters as disarmament of aggressor states, or compliance with sanctions against rearmament, can also frequently be implemented by air transport. Here, too, effectiveness requires immediate availability and speed.

The patrol of a border region pending completion of investigations or final settlement is another situation which would be greatly facilitated by air transportation. And finally, the ability to obtain information on actions under way in a recalcitrant state by means of aerial photography or visual observation will prove important. Throughout this discussion the emphasis is on preventing relatively small incidents or minor infractions from growing into major disturbances and finally full-fledged aggressions.

Should this step be ineffectual, however, the use or threat of use of the international air police force in bombing, strafing or dropping air-borne troops is still available. Its effectiveness will have been enhanced by the advance knowledge gained in the preliminary steps described.

Tests that may be applied to gauge probable success of such a police force are the following: First, effectiveness. An international air police force could act with speed, power and certainty. Next, general acceptability. Here it is felt that nations would be willing to authorize their representatives on the security council to call out such an internationally constituted police force without slow recourse to parliamentary procedures, whereas they naturally would be reluctant to permit use of national contingents by executive decision only. The final test is desirability, on which the whole case rests, it having been assumed that the organization of a world free from wars has almost universal appeal. The alternative is unbearable armament expense with commensurate reduction in economic and cultural progress, and eventually another war. Again I submit, the world is now of manageable size.

The question may well be asked—will the United States persist in its present determination to adhere to a world security organization; has the isolationism of the past disappeared; can there be assurance of no repetition of refusal to participate as occurred in the League of Nations experience? I can only answer by citing trends and present opinion. To the question, "Do you think the United States should join a world organization with police power to maintain world peace?" the response in a nation-wide sampling poll conducted in April, shown in comparison with previous polls, was:—

	Yes	No	No Opinion
1937 ...	26%	52%	22%
1941 ...	38%	39%	23%
1942 ...	59%	22%	19%
1944 ...	72%	13%	15%
1945 ...	81%	11%	8%

Of the 81% who expressed themselves favourable in April of this year, the response to the question which asked, "How important do you think it is that we join such a world organisation?" was:

Very important	83%
Fairly important ...	11%
Not too important ...	3%
No opinion	3%

It is here fitting to quote the words of that great American President, that great champion of the common man, that great worker for humanity and world peace, Franklin Roosevelt. A few days before his death he prepared a talk in which the following lines appeared:

"We, as Americans, do not choose to deny our responsibility. Nor do we intend to abandon our determination that, within the lives of our children and our children's children, there will not be a third world war.

"We seek peace—enduring peace. More than an end to war, we want an end to the beginnings of all wars—yes, an end to this brutal, inhuman and thoroughly impractical method of settling the differences between governments."

The insistence by President Truman in his first address to Congress that the policy of international co-operation and the programme at San Francisco initiated by President Roosevelt shall be continued, adds to my conviction that America will not be found wanting.

CONCLUSIONS.

Much of the foregoing is the result of speculations during my own twenty-eight years in aviation, which has been bounded by two world wars. To arrive at some conclusions concerning aviation's place in civilization; to seek out, if indeed it should exist, some worthy aim, has seemed compelling. I trust these findings will be of benefit, or at least suggestive, to others.

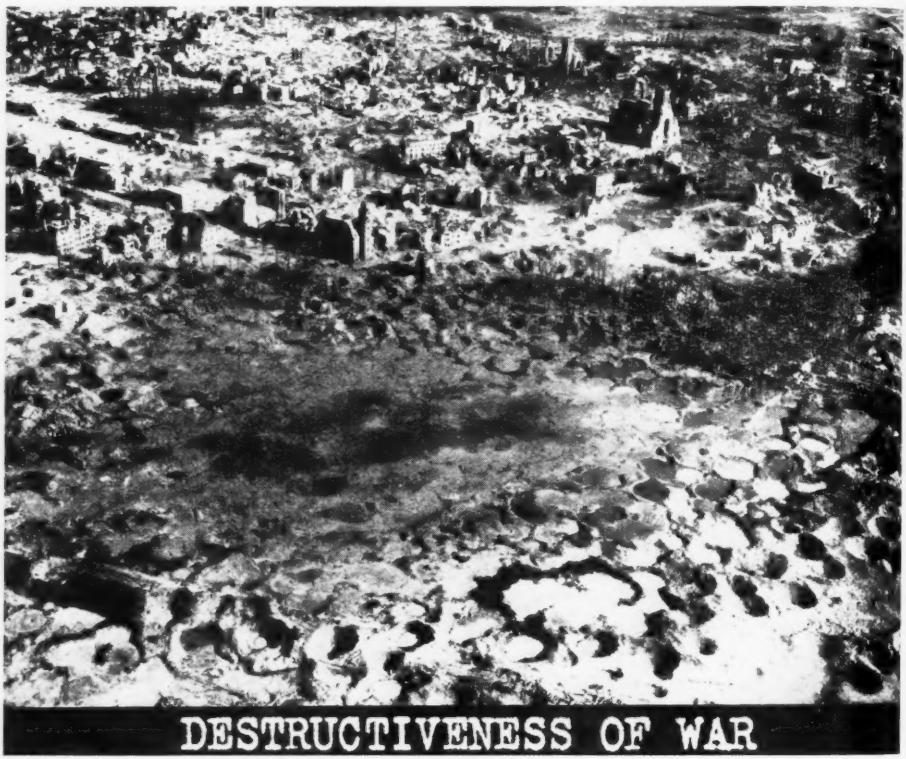


Fig. 19

It seems probable that the aspirations of millions of people throughout the world for a lasting peace with adequate security can be satisfied. An enforcing means is at hand —the airplane. The existence of an international air police force would make the enormous difference between being in time for prevention of action on the part of an aggressor and being too late to effect anything other than possible eventual victory in another world war.

My conclusions are ones of optimism. I believe the Neanderthal man is growing up; that the spiral of progress will, by virtue of the airplane, be benevolent; that air transportation and air power will be largely beneficial to the human family. This need not necessarily be so, nor will it come automatically, but that it will occur, because of

the work and efforts of men of good will now predominating in the world, I have no doubt.

The scientific method of analysis, fact to principle, must be applied in appraising science itself and its effect on civilization. War in destructiveness is, I fear, approaching a stage that is out of reach of man's recuperative powers. The pattern of warfare forced on us by our enemies has made it necessary for us to reply in kind, to answer destruction with greater destruction. We accept our responsibility for all measures of destruction that we have used. We must now strive equally for a world policy and organization, using aviation as a major tool, that will prevent global wars in the future. Let us not have more of the total destructiveness illustrated in the accompanying picture. (Figure 12.)

The progress of civilization, historically, has been closely associated with transportation. Speed of travel can be a gauge of leisure and social advancement. Has mankind evolved sufficiently to capitalize on what our technology has given us by advancing speed of travel five-fold in a generation? I believe so.

Technological development in aviation, far from pausing at present attainments, will continue more rapidly than ever before. World co-operation will accelerate this advance and world collaboration will determine its direction toward useful purposes.

The fields of usefulness for the airplane are manifold; their effects on society are staggering to the imagination. They encompass benefits in economics, in transportation, in communications and in culture. Government has a task to perform, both nationally and internationally in making the progress orderly. The trend must be toward greater emphasis on the human rights of the individual and of international responsibilities of nations. It takes one state to make a war—it takes all to preserve the peace.

A good start in international civil aviation was made at Chicago. The results were clouded by some set-backs from complete achievement, yet the way is open for further deliberations. With men of good will and determination to reach agreement, there is every hope for complete success next time. The best solution of the problem seems to me to lie in reaching agreement on general principles that a strong council of the International Civil Aviation Organization may apply with fairness and justice to cases differing one from the other throughout the world. Thus can maximum use and orderly development of world air transportation advance.

AIRPLANE VIEW OF AMERICA AT PEACE

This mural was done by Rockwell Kent, famous landscape and figure painter and wood engraver, and presented to the Committee on Interstate and Foreign Commerce, House of Representatives. The group of four angels flying outward to the four corners of the world forms the letter V for Victory and represents the four freedoms.

Aviation has much to contribute as an agency of peace in facilitating commerce; in bringing people together; in implementing an international security organization; in putting teeth in a league through organization

of an international air police force. Such force would be effective in the possession of speed, power and mobility. It will prove acceptable by the experience of war co-operation in operations and the universal will for peace.

Appreciating as I do how frequently Tennyson's "Locksley Hall" is quoted in aviation circles, I nevertheless cannot refrain from concluding my lecture with his beautiful and inspiring stanzas that express so well all I have wanted to say:

Men, my brothers, men the workers, ever reaping something new;
That which they have done but earnest of the things that they shall do.
For I dipt into the future, far as human eye could see,
Saw the Vision of the world, and all the wonders that would be;
Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight, dropping down with costly bales;
Heard the heavens fill with shouting, and there rain'd a ghastly dew
From the nations' airy navies grappling in the central blue;
Far along the world-wide whisper of the south-wind rushing warm,
With the standards of the peoples plunging thro' the thunder-storm;
Till the war-drum throbb'd no longer, and the battle-flags were furl'd
In the Parliament of man, the Federation of the world.
Then the common sense of most shall hold a fretful realm in awe,
And the kindly world shall slumber, lapt in universal law.

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10. Wings for Transportation (Franklin Institute Lecture)—T. P. Wright.
11. Transportation and National Policy (Air Transport Section)—J. Parker Van Zandt.
12. Thirty-first Wilbur Wright Memorial Lecture—Edward Warner.
13. Speech on Civil Aviation in the House of Lords, January 16, 1945—Lord Swinton.

Mr. W. C. Devereux, Vice-President of the Society, Fellow: It is a pleasure and a privilege to propose the Vote of Thanks to the Lecturer to-night. It is a greater pleasure in that Mr. Wright has been a personal friend of mine, as he has been to so many others present, for many years. Much more important is that he is a great friend of the Royal Aeronautical Society and a proven lover and helper of this country, and in the lecture given to-night we see that he is a great humanitarian. It is a blessing for the world that a man of his ability was available in the time of its greatest need and that he was prepared to give up a great position in industry in order to take the job as Director of Aircraft Control at the War Production Board.

I am privileged to testify to the great work that was done, because working as I did in charge of American aircraft supplies under Lord Brabazon's Ministry, I had occasion time and again to be thankful for the help received from Mr. Wright. In those days much misunderstanding and mistrust could have arisen at the time when we were modifying so drastically the aircraft received from the other side of the water: modifications occasioned by our experience in the fighting front; modifications which had been evolved out of that experience by Air-Marshal Sorley's tried young men. At that time it was somewhat difficult to impress upon American aircraft manufacturers the necessity which caused the cutting about of their beautiful, well-made machines because of the exigency of the moment—a situation that was clearly understood when they, themselves, came up into the fighting front, but in those early days the problems were settled by the understanding of such men as Mr. Ted Wright.

Many of us will well remember the paper given by the Lecturer at this Institute, which to a number of us was the first impression of those production methods that were to prove so satisfactory in giving us the large quantities of aircraft that helped us so much in this war.

The talk he gave a privileged few after the lecture left a profound impression upon me. That talk was on his experience then in Germany. What he told us proved later so completely right.

On civil aviation the figures that he presented that evening were staggering and showed a tremendous faith in the future, which should be a cure for much of the pessimism that was being abundantly shown in our own country at the time.

On the political, economic and cultural side, what the Lecturer has had to say this evening is very illuminating. Following the very practical talks we have had from him in the past, it is very encouraging indeed to hear Mr. Wright present these very liberal views on International co-operation and International trade. We know that these views are held by leading Americans and by intelligent people here, but in my recent visit to the United States, I found that they were not generally held opinions—no more than they are over here. Therefore it is very encouraging indeed to have public avowal of their beliefs by such a prominent man as Mr. Wright, as it is on the spreading of these ideas, which are corner-stones of Anglo-American relations, that future world prosperity and peace will depend. May the high hopes and faith shown by the Lecturer to-night spread far beyond these walls, and in that hope, Mr. President, I have the greatest pleasure in presenting a hearty Vote of Thanks.

Mr. PETER MASEFIELD, Member of Council, Fellow: It is my privilege to second the Vote of Thanks, and I do so with particular pleasure for two reasons. Firstly, because after all these years of using aviation for destruction Mr. Wright has shown the benefits which aviation can bring to mankind. And secondly, because the lecture is given by Ted Wright, to whom so many people in British aviation—including myself—owe so many kindnesses in the United States; and also in looking forward to a still closer association with him in co-ordinating British and American Civil Aviation in the future.

During these war years, ladies and gentlemen, we have had some historic Wilbur Wright lectures among which this evening's will take its place. They have marked our combined progress towards victory.

We had Roxbee Cox when we stood alone and Dunkirk was taking place.

We had Juan Trippe when Lease-Lend

was beginning. (Perhaps we could have done with Trippe as Lend-Lease, too.)

We had Moore-Brabazon in 1942.

We had Ed. Warner in 1943 in that classic lecture of his as the tide begun to turn.

And I think it is a very remarkable thing to think that, only a year ago, when Sir Roy Fedden delivered his Wilbur Wright lecture, we still had D-day ahead of us, we were still a little island off a hostile Europe with the towering and unbroken might of Germany challenging us from the beaches.

None of us knew what might happen when the last Wilbur Wright lecture was given.

And now this year Germany lies defeated —I suppose more completely than any nation has been defeated before. What an enormous change between the two lectures.

And I don't think it is an exaggeration to say that Ted Wright has played a very important part in bringing about that defeat —by his work on American aircraft production.

Four years ago, before he organised so much of that production—the Fortresses, Liberators, Mustangs, Thunderbolts, Marauders and Mitchells—which we know so well in British skies (but not so well as the Germans know them), Ted Wright made an estimate of what could be achieved in war production. That estimate has proved to be almost precisely right.

And now this evening he makes an estimate for peace—an estimate we all hope will come true and, on his record, will come true. Its up to us as the two chief nations engaged in Air Transport to make sure that it does come true.

So, after his great wartime contributions, it is particularly appropriate that Ted Wright should speak on the Civilising Aspects of Aviation. He was not even put off by being the thirteenth American to deliver the Wilbur Wright Lecture.

Ted Wright belongs to that happy band of far-sighted administrative men in aviation in which the United States is so fortunate. In having Wright and Warner—to mention only two of them—to deliver the Wilbur Wright Lecture one feels that this chief event in the Society's year is achieving its purpose—to draw our two nations more closely together each year.

We have heard a Wilbur Wright Lecture which will take its historic place beside its greatest predecessors. And in it we have seen the qualities of the lecturer. There are far too few Ted Wrights in this world.

The Vote of Thanks was carried with acclamation.

Following the Lecture the Annual Council Dinner was held at which the following were present:—

Mr. E. J. N. Archbold, B.Sc., Grad. R.Ae.S., Member of Council.

Professor L. Bairstow, C.B.E., F.R.Ae.S., F.R.S., Zaharoff Professor of Aeronautics, Imperial College.

Air Commodore F. R. Banks, O.B.E., F.R.Ae.S., M.I.Aut.E., F.I.P., M.S.A.E., Member of Council.

Mr. Griffith Brewer, Hon. F.R.Ae.S., Past-President, Royal Aeronautical Society.

Air Chief Marshal Sir Robert Brooke-Popham, G.C.V.O., Advisor to the Air Training Corps, Air Ministry.

Major G. P. Bulman, C.B.E., B.Sc., F.R.Ae.S., Member of Council.

Lord Brabazon of Tara, M.C., F.R.Ae.S., Past-President, Royal Aeronautical Society.

Mr. S. Camm, C.B.E., F.R.Ae.S., Member of Council.

Air Marshal Sir Ralph Cochrane, K.B.E., C.B., A.F.C., Air Officer in Command, Air Transport Command.

Mr. R. H. Coverley, C.B.E., Controller, Rotol Limited.

Dr. H. Roxbee-Cox, Ph.D., D.I.C., B.Sc., F.R.Ae.S., Member of Council.

Sir Charles Darwin, K.B.E., D.Sc., F.R.S., Director of the National Physical Laboratory.

Mr. W. C. Devereux, F.R.Ae.S., Vice-President, Royal Aeronautical Society.

Air Chief Marshal Sir Sholto Douglas, K.C.B., M.C., D.F.C., Commander in Chief, British Air Forces in Germany.

Mr. G. H. Dowty, F.R.Ae.S., Member of Council.

Mr. A. G. Elliott, C.B.E., F.R.Ae.S., M.I.Aut.E., M.S.A.E., Member of Council.

Air Vice-Marshal W. Elliot, C.B., C.B.E., D.F.C., Assistant Chief Executive, Ministry of Aircraft Production.

Mr. L. F. A. D'Erlanger.

Mr. W. S. Farren, C.B., M.B.E., M.A., F.R.S., M.I.Mech.E., F.R.Ae.S., Member of Council.

Sir A. H. Roy Fedden, M.B.E., D.Sc., F.R.Ae.S., M.I.Mech.E., M.I.A.E., M.S.A.E., PRESIDENT, Royal Aeronautical Society.

Mr. A. Gouge, B.Sc., F.R.Ae.S., Immediate Past-President, Royal Aeronautical Society.

Sir William P. Hildred, C.B., O.B.E., M.A., Director-General of Civil Aviation.

Mr. J. E. Hodgson, Hon. F.R.Ae.S., Honorary Librarian, Royal Aeronautical Society.

Commander J. J. Ide, U.S.N., U.S. Naval Air Attache's Office.

Commander Paul Johnston, U.S. Navy.

Mr. E. T. Jones, M.Eng., F.R.Ae.S., Chief Technical Officer, Boscombe Down.

Professor Sir Bennett Melvill Jones, M.A., A.F.C., C.B.E., F.R.Ae.S., Chairman, Aeronautical Research Council.

Air Vice Marshal R. O. Jones, C.B., A.F.C., Deputy Controller of Research and Development, Ministry of Aircraft Production.

Dr. Theodore Von Karman, California Institute of Technology.

Major-General W. E. Kepner, U.S.A.A.F., Commanding General, 8th Air Force.

Major H. R. Kilner, Chairman, Society of British Aircraft Constructors.

The Rt. Hon. the Viscount Knollys, Chairman, British Overseas Airways Corporation.

Captain A. G. Lamplugh, F.R.Ae.S., Honorary Treasurer, Royal Aeronautical Society.

Mr. B. Lockspeiser, M.A., F.C.S., F.R.Ae.S., Director of Scientific Research, Ministry of Aircraft Production.

Colonel W. R. Lovelace, Chief of Aero-Medical Laboratory, Wright Field.

Colonel H. N. McCoy, U.S.A.A.F.

Mr. P. G. Masefield, M.A. (Eng.), F.R.Ae.S., Member of Council.

Major R. H. Mayo, O.B.E., M.A., F.R.Ae.S., A.M.Inst.C.E., Member of Council.

Sir Frederick Handley Page, C.B.E., F.R.Ae.S., Member of Council.

Mr. R. K. Pierson, C.B.E., B.Sc., F.R.Ae.S., A.M.Inst.C.E., Vice-President, Royal Aeronautical Society.

Mr. E. N. Plowden, Chief Executive, Ministry of Aircraft Production.

Captain J. L. Pritchard, Hon. F.R.Ae.S., Hon. M.I.Ae.S., Secretary, Royal Aeronautical Society.

Air Marshal Sir James Robb, Air Officer Commanding in Chief, Fighter Command.

Major T. T. Samarin, Assistant of Military and Air Attache of the U.S.S.R.

Mr. Livingstone Satterthwaite, U.S. Commercial Air Attache.

Lord Sempill, A.F.C., F.R.Ae.S., Past-President, Royal Aeronautical Society.

Major B. W. Shilson, O.B.E., M.I.Mech.E., F.R.Ae.S., Member of Council.

Mr. George S. Schairer, Boeing Aircraft Corporation.

Sir Oliver Simmonds, M.A., F.R.Ae.S., M.P., Member of Council.

Admiral M. S. Slattery, A.F.R.Ae.S., Chief Naval Representative, Ministry of Aircraft Production.

Professor R. V. Southwell, M.A., F.R.S., F.R.Ae.S., Rector, Imperial College.

Air Marshal Sir Ralph S. Sorley, C.B., O.B.E., D.S.C., D.F.C., F.R.Ae.S., Controller of Research and Development, Ministry of Aircraft Production.

Lord Swinton, Minister of Civil Aviation.

Rear-Admiral T. H. Troubridge, C.B., D.S.O., Fifth Sea Lord.

Captain C. F. Uwins, A.F.C., O.B.E., F.R.Ae.S., Member of Council.

Mr. C. C. Walker, F.R.Ae.S., A.M.Inst.C.E., Member of Council.

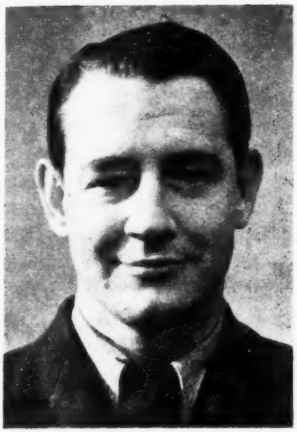
Air Commodore F. Whittle, C.B.E., F.R.Ae.S.

Mr. H. E. Wimperis, C.B., C.B.E., M.I.E.E., D.Eng., F.R.Ae.S., Past-President, Royal Aeronautical Society.

Colonel C. G. Williamson, Military Air Adviser to American Representative on the European Advisory Commission.

Mr. L. A. Wingfield, M.C., D.F.C., A.R.Ae.S., Solicitor, Royal Aeronautical Society.

Mr. T. P. Wright, F.I.Ae.S., Hon. F.R.Ae.S., Administrator of Civil Aeronautics, U.S.A., 33rd Wilbur Wright Memorial Lecturer.



TEST FLYING

by

Squadron-Leader J. R. Tobin, A.F.C.

Squadron-Leader Tobin served as a test pilot at the R.A.E. from May, 1940, to December, 1943, and during most of this time he was engaged on aerodynamic work, being for several years the Officer Commanding, Aerodynamic Flight. Later he performed similar duties while on loan to Blackburn Aircraft, Ltd. His success as an experimental test pilot was due to an unusual combination of personal qualities.

Much of his flying involved a more than usual degree of hazard, and called for courage combined with expert technical knowledge and an analytical brain. He engaged in numerous accident investigations, during which he would deliberately put the test aeroplane out of control in order to throw light on undesirable characteristics. Much of the pioneer work on high normal accelerations and on dives at speeds approaching that of sound was undertaken by Squadron-Leader Tobin, and his services in these directions led to the award of the A.F.C. in 1942.

Squadron-Leader Tobin's work was of the highest value to the technical departments, in addition to which he was also involved in the Battle of Britain, and was a pioneer of the gliding work done at R.A.E. Squadron-Leader J. R.Tobin lost his life in March while carrying out a test, and with his death the country lost one of its finest test pilots.

Introduction.

Test Flying should not be confused with Flight Testing. There is a very large difference between the two. Flight Testing covers the work of an infinite variety of people, while Test Flying is done by pilots and observers only. It is with the work of the pilots that this paper will deal.

What is a Test Pilot?

A Test Pilot is presumably a pilot who tests aircraft, but it is a very loose term. Out of the multitude of pilots engaged on test work in aircraft, only a small percentage actually test the aeroplane itself, while the remainder may be divided into two classes: those who do flight inspections, and those who use the aircraft merely as a vehicle for the testing of equipment and engines.

We find therefore that Test Pilots may be classified under three main headings:

(1) Pilots who actually test aircraft;
(2) Pilots who do final inspections;
(3) Pilots who use the aircraft as a vehicle for testing equipment, engines, etc.

Under the first heading there are:—

(a) Prototype flying;
(b) Aerodynamic experimental and research flying;
(c) Acceptance testing.

The second heading covers:—

(a) Production testing;
(b) Maintenance Unit flying.

The third consists of such a large variety that no list has been compiled, but includes such items as Wireless, Armament, Instruments, etc.

It might be imagined from this analysis that pilots would be carefully selected for these various jobs by reason of special qualifications, but such has not been the case in the past.

Until very recently there was no system of training, and pilots found themselves doing important test work and learning the job at the same time. In production and equipment flying this state of affairs was unsatisfactory but not serious, but when it comes to testing the aircraft itself, inexperienced piloting is not only dangerous, but is a very serious obstacle to progress.

Considering this situation, it is remarkable that such fine results have been obtained. The reason is that out of those inexperienced test pilots who are generally chosen for their skill as pilots only, there managed to survive the essential few who keep designers, technicians and scientists on the correct lines. In a way it is a survival of the fittest, and the longer they survive, the greater their value.

With production, maintenance unit and equipment testing, this talk is not concerned; any pilot with a reasonable amount of patience and common sense can very quickly cope with any demands made upon him. The work is often exacting and exasperating, calling for patience and tolerance, but the needs are clear cut, and the results required are generally definite.

Aircraft Testing.

We come now to the main item, that is, the testing of actual aircraft. The most important branch of this is undoubtedly prototype work.

Flying is, after all, still in its infancy, and when a designer produces a new type, his theoretical figures for behaviour are generally very theoretical; the word "theoretical" looming large in his vocabulary. When the aircraft is ready for its first flight, the pilot becomes, in effect, the key man. It would be expecting far too much to produce a perfect type straight from the drawing board, and it is on the pilot's reports the designer must make his modifications. On the occasion of the first flights, the designer is standing at the junction of a very large number of ways, only one of which is the right way, and it is generally full of pot holes, pit falls, and paved with broken flints. The other ways are often smooth of surface and lined with roses, but if one looks closely, the skeletons of aircraft that fell by the wayside may be seen among the flowers.

It is at this point that a good test pilot is most essential. The designer must not be mislead in any way whatsoever, and it is so very easy to do just that, for a variety of reasons. An inexperienced pilot may miss a lot that is happening, and put a wrong construction upon what he does notice, through no fault of his own. Another pilot may be so vague that wrong constructions may be put on his remarks. Others have not the courage of their own convictions and allow themselves to be talked out of some belief they hold. Probably the worst case of all is the pilot who tells a terrific story. Invariably the story is inaccurate or exaggerated. A pilot may make a report as breath-taking as he likes, provided that every word of it is absolutely true. Any one of the types mentioned is much more likely then not to lead the designer down the wrong path.

The perfect test pilot does not exist, but if he did, he would have the following qualities:

(1) Exceptional flying ability.
(2) The honesty to tell the truth, the whole truth, and nothing but the truth;
(3) The courage of his own convictions;
(4) Awareness, which is a seventh sense which enables some pilots to realise what is happening all over the aircraft;

(5) Patience, and lots of it;
(6) A good practical knowledge of aerodynamics, engines, etc.;
(7) The courage to take a justifiable risk when necessary, and the sense never to take one unnecessarily;
(8) A realisation of his own limitations.

To be a test pilot, these qualities are all necessary, and the value of any pilot may be judged by the percentage he possesses of all qualities.

Unfortunately, pilots seem to have been chosen for this particular work on number one alone. That is, exceptional flying ability. It is the more unfortunate because among non pilots, foolish, flashy flying near the ground often gains a pilot a high reputation. In point of fact, such flying is not only in extremely poor taste, but also shows a lack of appreciation of aircraft and aerodynamic laws.

In consequence of this, the wrong type is often selected for the job.

With regard to the other points it may be assumed, and correctly so, that no pilot would be deliberately dishonest, but such strange inexplicable things so often happen on test flights that for fear of appearing foolish, pilots may not mention them, or even give an account which sounds more reasonable, arguing with themselves that their own observations have been wrong, or that their own flying was at fault.

The truth must be told, no matter how foolish it may sound; nine times out of ten the pilot is right, though he may often have to wait a long time before he is proved so theoretically.

That brings up the point of a pilot having the courage of his own convictions. When a pilot reports a peculiar circumstance, he is very likely to be subjected to a lot of auto-suggestion from the designer, scientist, or whoever is controlling the ground work of the job. It is during the cross examination that his courage may be shaken.

Awareness is simply a matter of test piloting experience, nobody has it to start with, some will never develop it, and those who do, develop it slowly. It is a very useful sense for a pilot, and is born from a healthy respect for all aspects of flying. It results in the ability to sense any slight alteration in the behaviour of any part of the aircraft. This may not sound difficult, but it is, extremely so. It is a quality which allows a pilot to be fully aware of what his elevators are doing, whilst concentrating upon his ailerons. This quality is very valuable in the event of serious trouble. The experienced pilot will bring back a clear concise report, and will probably know the cause of the trouble, and his report may produce the answer to a long-standing problem. The unaware type will have only a very vague idea of what happened. A problem will remain unsolved, and probably a new one will be introduced, and unless the test is abandoned the trouble will most likely occur again. When a pilot first starts test flying he finds that he has inumerable questions flung at him which appear to have nothing whatever to do with the test upon which he was engaged, and he is unable to answer any of them. As time goes on he begins to anticipate these questions while still airborne, and looks for the answers in flight; thus he develops this awareness, and when he can answer 75% of the questions, he is becoming really useful.

Patience, as the old saying has it, is a virtue, and is a very necessary one for a test pilot. Peculiarly enough, it is generally lacking in the flashy, show-off pilots previously mentioned. Practically every test requires patience, but some much more than others. Take, for example, a test which requires half a dozen readings, measurements, or observations under three or four conditions at the maximum permissible diving speed. The maximum diving speed can probably only be held for a matter of seconds, so the pilot is lucky if he obtains three of the observations in one dive. Consequently, he has to climb up again, and repeat the dive to make the

other three observations of the half-dozen, so that two dives have to be made for each of say four conditions. If the pilot is conscientious he will probably repeat several of the dives to recheck his observations, totalling in all about twelve dives. If he is wise he will have performed the test at a height to give sufficient ground clearance in case of trouble, and the climb between each dive would be a laborious task. The impatient pilot would probably make his dives at a dangerously low altitude, skimp his observations, and neglect various fine points, such as accurate trimming, engine conditions, etc., which make all the difference between the success or failure of certain tests.

The sixth quality mentioned was a good practical knowledge of aerodynamics, engines, etc. The word "practical" should be stressed here. Too much theory is bad for a test pilot, the more theoretical he becomes the more his piloting ability suffers. This may be a debatable point, and there are exceptions to the rule, but in general it is true. One example was a pilot who became more and more theoretical every day; it was almost possible to see him balancing B1 over B2 while he was flying. One day, while engaged on stability tests at 35,000 feet, he became so interested in a phugoid that he allowed it to develop beyond control, and he found himself spinning inverted at 33,000 feet. Luckily the pilot in him quickly pushed aside the scientist and he managed to recover.

Point seven, the courage to take a risk when necessary and the sense never to take one unnecessarily, really requires no comment.

So much then for the prototype test pilot; he shares practically equally with the designer the responsibility for the success or failure of the aircraft. A note should be made here however that a good designer can often carry a bad pilot, but a good pilot can seldom carry a poor designer.

Aerodynamic Experimental and Research Flying.

We come now to aerodynamic experimental and research flying. This work differs from prototype flying in so much as it is generally done on standard aircraft. The other difference is that while the prototype test pilot has to help produce an aircraft, the experimental pilot has often to make it do things for which it was never originally designed, and by modification, change complete characteristics. He must be prepared to try out new ideas which may be good, but often are not, and he must be strong minded enough and have sufficient experience to draw the line occasionally. Great care has to be taken over this last point as scientists are often easily discouraged. Pilots are always left to say when an experiment is dangerous or not, and no pressure is brought to bear upon them. This is because the scientist does not want to hurt the pilot, and he knows that a crash will possibly ruin his experiment anyway.

Experimental flying is always interesting to the right type of pilot. The more he flies the more he realises how young flying really is, and how vast a region is still unexplored. In a way it is a modern form of pioneering, and carries with it the thrill, triumph, setbacks and hard work usually associated with such adventures.

Research and experimental flying go more or less hand in hand, and it is often difficult to differentiate between them. Long term research has, of course, suffered during the war, as was only to be expected.

Situated, as England has been, in the front line of the aerial war, the needs of the moment were more pressing than the needs of the distant future. It is remarkable, however, how much has been learned from these needs of the moment.

A large percentage of the experimental and research pilots' work at present consists of finding the answer to problems which arise in the Service. For example, an aircraft might suddenly, and for no apparent reason, develop a dangerous characteristic. The problem is then considered carefully from the theoretical side, and as full accounts as pos-

sible of the various incidents giving rise to the investigation are studied. In general, however, it is necessary to reproduce the incident in the air. Great care is always taken by all concerned on these occasions. Tail parachutes for recovery from spins are fitted if necessary, while the test is always made at an altitude of sufficient magnitude to enable recovery action to be tried, and failing that, enough height to abandon the aircraft. Considering the number of tests made, the latter contingency is very rare.

These investigations are usually of an urgent nature demanding an immediate reply. Unfortunately, experimental and research work is by its nature slow, and is very averse to being hurried. To rush headlong into such experiments is to court disaster.

It should not be imagined that pilots engaged on this work are able to give their undivided attention to one particular job. Generally they are working as many as fifteen to twenty experiments over the same period of time. The pilot must be prepared to fly any type of aircraft, often in an unorthdox manner. He must also be prepared to do an experiment in an aircraft he has never seen before, after a short handling flight. It is not uncommon for a pilot to fly, say, a Tiger Moth and Stirling during the morning, and a Spitfire and Marauder in the afternoon. The following day he might fly four or even five different types again, so that in two days he may have flown eight or nine different types on widely divergent work. This is an extremely valuable feature; apart from the experience it gives, it prevents a pilot becoming biassed in favour of any particular type. It is a fact that pilots after a period of flying one particular type, even if it is a shocking contraption, will swear it is the finest aeroplane in the world. One Spitfire pilot engaged on testing subconsciously compared everything he flew with a Spitfire. It was a good standard to use when flying fighters, but it fell down rather badly when used on multi-engined aircraft.

Acceptance Trials.

The pilots engaged upon Acceptance Trials have a very similar job to the Experimental and Research pilots. It is their responsibility to check that new aircraft entering the Service are up to a certain specified standard. In actual fact their work covers much more ground than that, but there is no time in this paper to go into fuller details.

Experimental and Research Work.

So far no mention has been made of any actual experimental work. It will be appreciated, of course, that in a paper such as this there is much that cannot be mentioned. A fair amount can, however, be said about the following subjects without giving away any secret: (1) Medical Research Flying; (2) Enemy Aircraft Testing; (3) Compressibility.

(1) *Medical Research Flying.*

Few people engaged on aircraft work ever stop to consider the medical aspect of flying. It is a subject that is clouded in mystery, in fact, one might almost go as far as to say that there are still traces of De Quincey's theory knocking about. De Quincey reckoned that if a stage coach exceeded a certain speed, the occupants would become apoplectic. It is now a well proven fact that speed itself has no effect on anyone, provided they are protected from the airflow.

In the early days of flying, the pilot was tougher than the aircraft. The limiting factor for any manœuvre was the machine, not the man. Aircraft, however, develop quickly, the new generation, while admiring their fathers, are very amused by the aeroplanes they used to fly. Science, while improving the aeroplane, has not, however, been able to make any radical modifications to the human body. Perhaps in a thousand years or so man will have developed new lungs, etc., but at present he has to be protected.

There is in existence a Physiological Laboratory staffed by a very able team of doctors, whose job it is to develop methods and equipment for the comfort and longevity of air crews. They are seldom heard of, being

modest people, and not bathed in the light of publicity, but they are doing exceedingly valuable work, quite often of a hazardous nature.

They have decompression chambers in which they do experiments at very high altitude conditions, but they prefer, as far as possible, to do their research actually in flight.

One of the experimental pilots is at their service, and some of the most interesting flying he does is in connection with their work.

A subject which has engaged their attention for a long time is blackout. Now most people know what blackout is, but few seem to appreciate its effect upon high speed flying.

Everybody knows that a bucket containing water if swung in a circle with sufficient velocity, will not spill the water, owing to centrifugal force forcing the water to the bottom of the bucket. A similar occurence happens in flight during a loop, pull-out, tight turn, or any other similar manœuvre. The pilot is travelling quickly round the circumference of a circle, with his head towards the centre. The boney frame of his body will remain unchanged but his blood and all the fleshy parts of his body will try to go to his feet. The first parts to be affected by blood starvation are the eyes. First of all distant objects become out of focus, then nearby objects, such as cockpit instruments, then complete loss of vision. If the same amount of G is then maintained for some seconds, unconsciousness will follow, as the brain itself becomes starved of blood.

That, very briefly, is the case.

Carefully conducted experiments found that the average pilot blacks out between 4½ and 5 G, so it will be seen that the heart which has normally to overcome only 1 G is capable of pumping against 4½. It was designed, evidently, with quite a large safety limit. The value of the acceleration at which a pilot "blacks out" is termed the threshold.

It was also found that a pilot who normally blacks out at 4½ G could go quickly to 6 G without loss of vision, but would black out at 4½ as the G was being relieved. So the time factor is quite important. It is possible to apply momentarily, say, 9 G without loss of vision, provided the application and release is of a very short period. In fact, jumping off a foot-stool on the ground and landing on the heels with the body held rigid produces about 12 G. This is not recommended as a pastime.

Other points found were that under certain conditions pilots' thresholds were lower than normal; these were:—

(1) Applying G while screwing the head round. This, of course, is quite common during a dog fight. The threshold is lowered considerably.

(2) Sun glare lowers a pilot's threshold in proportion to its strength. Sunlight reflected upwards from the top of cloud is probably the worst case as the eyes are not naturally protected against strong light from below. These conditions will drop thresholds as much as 50%.

(3) Fatigue lowers the threshold in proportion to its intensity.

(4) Lack of oxygen.

(5) Excess nicotine and alcohol. This point is theoretical, no experiments having been carried out to prove it.

(6) Negative G immediately before positive G.

It is possible to build up a resistance to the effects of G by adopting a crouching attitude, holding the breath, contracting all muscles especially stomach ones, and using lots of willpower. It is possible in this way to maintain vision up to 7½ or 8 G, provided the pilot has a normal healthy resistance to start with. Raising the feet in order to reduce the vertical distance between the heart and the feet also helps. If a prone flying position could be adopted exceptionally high G could be reached. The Germans have tried this in an experimental aircraft.

Negative G.

Negative G is the opposite of positive G. The difference is that the pilot has his feet towards the centre of the circle and consequently the blood is forced to the head. The effect of excess negative G is extremely unpleasant and can be harmful. Resistance to it varies with the individual, each pilot having what is known as his "red-out" threshold. The sensations caused by Negative G start generally with the stomach, which feels as if it were rising up. This is followed by suffusion of the face, the soft tissues of which and the eyelids are felt to jerk upwards. Finally, brightly coloured catherine wheels seem to start flying about accompanied by a feeling of pressure on top of the head. Pilots with high resistance generally "red-out" about 3½ G. It should be borne in mind that this represents a difference of 4½ G from normal.

The effect of Negative G can be very serious; it can cause unconsciousness more quickly than positive G, and this unconsciousness may last up to a minute, which is quite long enough for a pilot. Even without becoming unconscious, pilots are often left feeling decidedly unwell after a bout of Negative G. It is possible, as in the case of positive G, to build up a certain resistance, however.

High Altitude Flying.

The medical side of high altitude flying is mainly concerned with pressure, oxygen, and warmth.

Pressure.

Some people have an idea that oxygen is not used in pressure cabin aircraft; this is wrong.

First of all pressure is not maintained the same as that as ground level; the internal height, especially in fighters, may be such as to require oxygen to maintain life, depending on the actual height of the aircraft. Figures, of course, cannot be given. Secondly, in the event of the pressurising system failing it is doubtful if the crew would have time to put on oxygen equipment before they were overcome. The main object of pressurising is to avoid "bends," not to dispense with oxygen equipment.

Oxygen.

Everyone nowadays recognises the importance of oxygen at heights above 15,000 feet; but there is one aspect very seldom realised. In the region of 44,000 feet and above, even though 100% oxygen is being breathed, there is a grave danger of passing out through being inoxic. The reason is that owing to the low pressure, the amount of oxygen taken into the lungs is insufficient to support life. It would seem, therefore, that pressurising becomes essential above 44,000 feet to be able to live, let alone to prevent "bends."

With regard to the question of warmth, there is little to say here except that it is no easy matter to strike a balance all over the aircraft between too hot and too cold.

Other Aspects of Medical Research Flying.

Medical research in flying covers a variety of subjects such as Carbon Monoxide poisoning, night and day vision, etc. These subjects, however, hardly come under the heading of Test Flying.

Enemy Aircraft Testing.

Enemy aircraft testing is done by the experimental and research pilots. When an aircraft is delivered by the Luftwaffe in a flyable condition, or which can be repaired sufficiently to fly, and about which information is required, then the following happens. Permission has first to be received from certain quarters before it can be touched at all, of course. When this is received a working party visits the aircraft and reports on its condition. If it is decided to fly the aircraft away from where it landed the working party set to and prepare it for flight immediately. If it is not to be flown out they dismantle it immediately for despatch by road or rail.

On a type about which very little is known, the first tests made are performance. These

consist of finding top speed at all heights, especially maximum rated altitude, rates of climb at all heights, and absolute ceiling. When these have been established research handling takes place. There is often a lot to be learned about aerodynamics from the enemy. Engine performance is of course studied closely throughout the foregoing tests. Special equipment such as wireless, etc., is of course handled by the appropriate department. It is often difficult to stop the enthusiastic scientist whipping off his particular bit which might affect the behaviour of the aeroplane before it has flown at all. Certain operational pilots are invited to fly in order to obtain a first-hand idea of their opponents' equipment.

The following aircraft have been tested at one time or another:—

Heinkel IIIK, Junkers 88, Messerschmitt 110, Messerschmitt 109, Fiat CR42, and Focke Wulfe 190.

The Heinkel IIIK was the first; there was little to learn from this aeroplane. It behaved more or less as was expected, and felt what it was, an air liner converted to military use. The practically frictionless control circuit was quite impressive, and started the pilots shouting for less friction in British types. An unusual feature was the pilot's seat, and controls which could be raised or lowered hydraulically by means of a lever next to the pilot's right hand. The raised position popped the pilot's head out of the top of the fuselage like a pea on a marrow. There was a small windscreen which could be raised manually. This position was used on the ground and for take-off and landing. The lower position was rather like sitting in a glass room. Vision was so obstructed that instrument flying was, if anything, preferable. While the seat was rising there was a feeling of loss of control at first, but this disappears with use. The controls are averagely responsive, though on the slow side, and become very heavy with speed; their feel is poor and spongey.

The Junkers 88 has an extremely fine record and is a very fine aircraft. It was designed from the ground up as a military aeroplane, and there is no unnecessary part on it. It is lovely to fly, and although it is no Magister, it is not difficult. The controls are averagely light, although they are pretty heavy at high speed, but their chief good feature is crisp response. They are well harmonised and have progressive increase of force with displacement. The ailerons have a very ingenious attachment consisting of a weight on an arm helping to operate the control. View from the cockpit is not very good, being badly spoiled by formers and supports. The cockpit is also very cramped. Her performance at the beginning of the war was in the top class, and with the new BMW engines she has managed to stay in that class. A good all-round operational fighting aircraft.

The Messerschmitt 110 was referred to by the pilots as a gentleman's aircraft. Astually she is a lady; though unlike most she has no vices. Her performance when she first came out was, like the Ju. 88, in the first class, and she is still good enough to put up a show even now. The cockpit lay-out was good and comfortable. View was good all round and more or less unobstructed. Controls were well harmonised and crisp in response, but too heavy, especially at high speeds. . Stability was very good, being especially noticeable on the glide. The landing was easy owing to this stability as control was also good during the glide.

The ME. 109 is a fast aeroplane with heavy controls at high speeds, a dislike of turning to starboard, and light controls with skittish response at medium and low speeds. It has a bad habit of dropping a wing near the stall. The slots cause a bad snatch on the ailerons as they open, especially as a high speed stall is approached. Bad features are: lack of view for take-off and landing, poor turning circle, very heavy elevators at high speed, and the wing dropping act, coupled with a narrow track undercarriage. A good feature is the lay-out of the cockpit controls for flap operation, and elevator trimmer. The flaps are wound down manually by a wheel, an identi-

cal wheel is placed next to it to operate the tail trim. By grasping both in one hand and winding together the nose down pitch caused by the flaps is not noticed. She has a good rate of climb, coupled with a steep angle of climb, which is very useful in air combat.

The Italian fighter, the Fiat CR42 is not worth talking about. It was a bad version of a Gladiator really.

Last but not least there is the F.W. 190. This aeroplane is quite famous, and rightly so, except that it has become famous for properties it does not possess, and its good features are ignored.

Its performance figures are not outstanding by any means, and its manœuvrability leaves much to be desired. Like the ME. 109, its turning circle is poor, its controls, though light and skittish at medium and slow speeds, are too heavy at high speeds. It has a very high rate of roll, however, and this has gained it a reputation for manœuvrability which it does not possess. Its good points are the all electric services operated by push buttons in the cockpit; the general cockpit layout; the marvellous all-round view in flight; the extremely good engine installation and the fact that despite the use of a 1,700 horse power engine, no rudder trim is required.

To finish with German aircraft it should be mentioned that tail trimming is invariably done by the tail plane, and that their fighter cockpits are designed so that the pilot is as near a prone position as possible to give protection against G. Their cockpits are evidently designed for small men.

(3) *Compressibility.*

Flying is now reaching a most interesting stage. The stage of compressibility. Compression occurs when an object is moving through the air at a speed which is too great for the air to flow round it. The air, in other words, just has not time to get out of the way and consequently is compressed. It will be appreciated that the shape and frontal area of the object affects the stage at which compression occurs. The object passing through the air imparts a local acceleration, and compression occurs when this local acceleration reaches the speed of sound. Sound is conveyed through the atmosphere by pressure waves. The speed of sound varies according to the density of the medium through which it is passing. Water, for example, would carry it quicker than air. In consequence of this, owing to lowering density with increased altitude, the speed of sound is slower at high altitude than at ground level.

Aircraft in service to-day have not been specially designed to operate at speeds in the region of the speed of sound, but owing to their clean lines and high ceilings, some of them cause sufficient compression during dives that there is a marked effect on behaviour. It should be stressed that only a percentage of the speed of sound need be reached by the aeroplane to cause considerable compression of the air. This percentage is referred to as Mach Number, the figure being taken as the speed of sound. The speed of sound at ground level is 762 m.p.h. true, and at 25,000 feet 693 m.p.h. true. These figures vary, of course, according to weather conditions, but can be accepted for a survey of the situation. Now an aircraft at 25,000 feet travelling at a true speed of 554 m.p.h. registers a Mach Number of .8 as 554 is 80% of 693.

Various parts of an aircraft cause compression at fairly low Mach Numbers, such excrescences as radiators, windscreens, rear view mirrors, etc., but no serious effects are caused until the wings themselves begin to cause shock waves. Excrescences can cause some troubles, of course, such as buffeting, yawing, etc.

The Mach Number at which the wings cause compression varies between aircraft. Results point to a thinner wing section reaching a higher number.

Tests are always made at as great an altitude as possible so that there is room for recovery from trouble, and so that the phenomenon may be studied at lower true speeds and consequently, lower control loads. Dur-

ing these dives events take place more or less in the following order. The initial stages as the Mach Number is growing are normal. Next there is a general mild buffeting, probably caused by various projections starting to shock stall. After this buffeting there is a period of steady diving with increasing number. Just before, or just as the wings start to cause compressibility, there is a likelihood of the ailerons being moved by some force which can, however, be held. When the wings go there is fairly quick but smooth nose down pitching moment. This nose down trim may or may not be counterable on the stick, depending on the type of aircraft. Considerable elevator movement is required, and the forces are generally very large. Use of the trimmer tab is not recommended except in dire necessity. The reason is that should the shock wave cease at a lower altitude, the nose up moment helped by trimmer may generate sufficiently high loads to break the aircraft.

It must be borne in mind that should a shock wave occur during a dive at high altitude, and stick forces are to great to pull out of the dive, there is no need for immediate panic. A little quiet weeping or perspiring is permissible, but it should be remembered that although your indicated air speed will continue to rise as you descend, the speed of sound will increase even more, and the gap between your true speed and the true speed of sound will widen until the shock wave will suddenly stop and normal air flow resume. This of course is not a golden rule, as on some aircraft the gap might not widen sufficiently before Mother Earth is reached, and entered several yards.

To conclude this subject, it was interesting to note in the cockpit of German fighters a list of limiting diving speeds against height. They have evidently been running into trouble. Incidentally an under-wing pitot head becomes practically useless after the onset of a shock wave and a compressibility correction is required on a leading edge type.

General Conclusion.

During the war years speed of flight has leaped forward enormously and it has been done by going to high wing loadings, new wing sections, and increased power. Each of these factors has brought its own problems and difficulties, and it with these problems that the modern test pilot has to deal. Controls nowadays have to be light and effective throughout a speed range of 100 m.p.h. to 500 m.p.h. Terrific power units up on the nose try to take charge, and have to be held in leash by careful design. High wing loadings mean high stalling speeds, and new sections often mean different stall characteristics. Imagine wing loadings between 50 and 60 lb. per square foot compared with those in use before the war. In finishing, I should like to mention instrumentation as it is a good basis on which to start a discussion. Will it ever supplant the test pilot completely, or will there always be a point beyond which it cannot go?

AIRWORTHINESS OF CIVIL AEROPLANES

by

W. Tye, B.Sc., A.F.R.Ae.S.

For several years Mr. Tye has been closely connected with airworthiness matters. He is on the staff of the Air Registration Board, and in this capacity has been concerned with the recently issued British Civil Airworthiness Requirements. From 1939 to 1943 he was employed at the Royal Aircraft Establishment, where, as Secretary of the Joint Airworthiness Committee, he dealt with military design problems.

(This lecture was read before the Graduates and Students' Section in March, 1945)

IN this lecture the aim is first to establish of position of "airworthiness" in the field of "safety". To draw a comparison, airworthiness is but one element of a complex jigsaw puzzle in which all the pieces must properly interlock in order to produce a satisfactory safety picture. This parallel applies too in the sense that if the shape of one of the elements is altered, all the adjacent elements must be altered to maintain a perfect fit. Arising from this, it is clear that, if safety and efficiency of air transport are to increase, then airworthiness provisions must be ever more closely linked with the conditions under which the aeroplane operates. The second aim is to draw attention to those airworthiness matters to which the designer could most profitably direct his efforts.

Safety.

This section is concerned with safety in flight and in other operations such as landing, take-off, and taxying which are essential for flight to take place. Now safety is a relative condition, rather than an absolute one. It can be said that aeroplane A is safer than aeroplane B, meaning that the chances of A avoiding an accident are greater than those of B. It is not possible to say categorically that A is safe and that B is dangerous. It is however permissible to classify the degree of safety and then to say that aeroplane A lies above a certain minimum acceptable standard and that B lies below this standard. Such a standard is necessarily arbitrary in conception and is determined largely by what we are accustomed to expect, both in relation to the use of aeroplanes themselves, and in relation to other day-to-day risks.

In order to discuss the degree of safety quantitatively rather than qualitatively it is convenient to use the conception of "accident rate". Accident rates can be expressed in various forms but broadly they amount to statements of the kind that X accidents have occurred (or are likely to occur) in Y hours (or miles) flying. The usefulness of an air passenger service can be measured in terms of the number of "passenger-miles". The comparable measure of the hazard is the number

of passenger fatalities. The number of fatalities per million passenger miles is therefore a useful criterion of the safety of passenger carrying aircraft. If damage to the aeroplane itself is of primary concern, a serious matter to the owner, the number of accidents per million aircraft miles is a useful measure of safety. There are, of course, many ways of expressing such results, each having its particular uses.

It is sometimes argued that the idea of accident rates as described above, though scientifically above reproach, is in practice somewhat misleading. This counter argument is based on the fact that the general public hears of accidents as an absolute number, but knows nothing of the number of hours of accident-free flight. Thus public opinion may weigh heavily against aviation if there were more than X accidents per annum—regardless of the amount of flying in the year. If this is so, and there is much to be said for this view, those concerned with safety will have to ensure that as the amount of flying increases the accident rate is correspondingly reduced.

Provisions to ensure safety.

To ensure that the aeroplane has the desired degree of safety several provisions must be made. To summarise:—

(a) the flight crew must be adequate in number and competence to control and navigate the aeroplane;

(b) the flight must be planned by competent staff;

(c) proper radio and meteorological services must be provided;

(d) the aerodromes used by the aeroplane must be suitable in layout, construction, equipment;

(e) the aeroplane must be suitably designed, constructed and equipped having regard to its uses;

(f) the aeroplane must be maintained in a satisfactory condition by a competent engineering organisation.

It is now possible to begin to see why the various safety provisions are closely interwoven with and dependent on each other. For instance, the degree of strength provided depends to some extent on the competence of the pilot. The anti-ice equipment provided may well be a function of the adequacy of the meteorological services. Again, the strength provided may depend on the efficiency of the meteorological service in forecasting gusty weather. Examples such as these are numerous.

"Balanced" safety.

In the course of time the several provisions made towards ensuring safety find their own level. Whether or not the balance between them is the most economical is a question worthy of investigation. Though the solution to such problems is not easy, the problem itself is clear. It is this—having established a desirable standard of safety, what is the best way of attaining this in order to achieve the greatest value from the use of the aeroplane for a given expenditure of effort? Some idea of the nature of the solution could be obtained if we were able to analyse accident evidence sufficiently well to be able to be certain of the underlying cause. This is not wholly possible. Quoting from U.S.A. air transport statistics, the percentage accidents due to several causes are shown below for three years.

These figures are drawn from the Civil Aeronautics Journal issued by the Civil Aeronautics Administration.

This table is subdivided into very nearly the same groups as was considered previously in relation to the various provisions for safety. The percentage accident figures for the three years quoted vary considerably but we may nevertheless draw some broad conclusions from them. Assuming that present and future civil flying exhibit roughly similar proportions of accident causes, this Table suggests that improvement in piloting skill, (a) of the section on safety and in aeroplane design and maintenance (e), and (f), would be most

	1940	1941	1942	Mean for Three years
Pilot error of judgment, poor technique, disobedience, carelessness.	41	49	28½	39½
Other personnel errors (excluding maintenance staff).	5	8	12½	8½
Weather and darkness	12½	8	14½	12
Airport and terrain	12	6	14½	11
Aeroplane failure (due to design, construction and maintenance)	26½	21	16	21
Miscellaneous and undetermined	3	8	14	8
Total:	100	100	100	100

fruitful in reducing accident risk. Statistics for non-airline aeroplanes (*i.e.*, mostly privately owned, training and touring aircraft) lead to the same conclusion, an even larger proportion of accidents being caused by "pilot error."

This is however only half the solution to the problem. To complete it, it is necessary to know the expenditure of effort necessary to improve any one of the safety provisions beyond their present level. Such an investigation is clearly beyond the scope of this paper but sufficient has been said to indicate how the several safety provisions could reasonably be balanced to obtain the most efficient results.

An important point is that accidents attributed to pilot's errors (39½%) could often be prevented by suitable aeroplane design. For instance, simplification of the controls (flight, engine, landing gear, etc.) would tend to reduce pilot errors. It seems clear that however highly pilots are trained, there is always a liability to human error. The author suggests that it is more profitable to build into the aeroplane itself all possible devices to avoid pilot errors, rather than to attempt super-training of pilots. This should however not be carried to such an extent as to discourage pilots from becoming skilful—always a potential danger of over-simplification.

Airworthiness.

The two sections of the safety organisations which are normally viewed as airworthiness are those of (e) and (f) of the section on safety. Unfortunately the accident evidence available does not permit splitting the aeroplane failures into those associated with "design and construction" from those associated with "maintenance." Both matters are clearly important, but it is proposed only to discuss the former as it is impossible to do justice to both in a brief survey.

To obtain the required degree of airworthiness of the aeroplane as a whole the designer must—

(a) provide a structure of sufficient strength to withstand the loads arising in flight, landing, take-off and other necessary manœuvres;

(b) provide sufficient structural stiffness to prevent flutter and dangerous vibrations, and to prevent deterioration of control and stability due to structural distortion;

(c) provide sufficiently reliable mechanisms (*e.g.* undercarriage retraction, etc.);

(d) provide satisfactory stability, control, and performance;

(e) provide a sufficiently reliable power plant;

(f) provide the necessary instruments and equipment and ensure that these are sufficiently reliable;

(g) provide safeguards against the miscellaneous hazards of flying such as outbreak of fire, and formation of ice;

(h) provide safeguards to reduce the consequences of accidents should (a) to (g) prove insufficient.

Again it is profitable to consider accident statistics grouped as closely as possible under the headings. The mean figures for three years on U.S.A. transport aircraft are:—

		%
(a) Strength of structure (b) Stiffness of structure (c) Mechanisms	Landing gear	13
	Structure other than Landing gear	0
(d) Stability and control		1
(e) Power plant		7
(f) Instruments		0
	Total:	21

The two subsidiary headings (g) and (h) of the section on airworthiness do not appear as separate items in this grouping.

When considering the figures of the above table it is necessary to bear in mind that the purpose of airworthiness requirements is twofold—to reduce the number of accidents causing fatalities and injuries and to reduce the accidents causing material damage. The former is the more important function, and the provisions made in respect of the former go some way towards assisting the latter. Accidents associated with structural failure in flight, loss of control, power plant failure are frequently serious in consequence. Undercarriage failures on the other hand are rarely fatal but are serious as regards material damage because of their frequency.

It is striking that the landing gear accounts for all the accidents with structural and mechanical causes. Thus it seems that structural failure in flight, and aero-elastic troubles—flutter, reversal, etc., very rarely occur. Of the landing gear failures it is likely that some are structural and some mechanical, associated with the retraction mechanism. Many of the so-called "pilot error" accidents are associated with landing and take-off, and it may be that an increase in the standard of strength of the landing gear would reduce such pilot error accidents.

Stability and control troubles apparently cause few accidents but it must be remembered that many pilot error accidents are so closely bound up with stability and control, *e.g.*, stalling and spinning properties, that improvement in these characteristics may have a profound effect on those accidents now attributed to the unfortunate pilot.

In addition to the interdependence of the several safety provisions already mentioned the significance of the wording of (e) of the section on safety must not be overlooked, *" the aeroplane must be suitably designed, contsructed, and equipped, having regard to its uses."*

This means that the airworthiness of the aeroplane is meaningless unless considered in relation to the uses to which the particular aeroplane is put. This has of course always been recognised, as for example in the selection of different strength conditions for the trainer, and the civil transport. As design develops, however, the characteristics and uses of various classes of aeroplanes become more widely different. These differences must be reflected in the airworthiness requirements —otherwise there is a risk of some aeroplanes being unsafe while others are too safe and operationally inefficient. This aspect of the matter becomes clear when particular airworthiness requirements are considered.

Structural Strength.

The most important loading conditions are those determined by:—

(a) the normal accelerations imposed by the pilot during manœuvres;

(b) the normal accelerations due to atmospheric gusts;

(c) the accelerations during take-off and landing.

The manœuvring accelerations in flight are the simplest example of the need to relate the design conditions to the operational use. The high manœuvrability of the acrobatic aeroplane is reflected in the high acceleration used for design purposes—the low manœuvrability of the transport allows low accelerations to be used in design. The I.C.A.N. recognised this by dividing aeroplanes into two categories, normal and acrobatic.

It seems however that the time is ripe for a more flexible system involving a greater number of categories, to allow the purchaser freedom to choose the most suitable type for the intended purposes. A possible set of categories (thinking chiefly in terms of strength) is:—

Category	Designed to withstand accelerations of:
Super acrobatic	8g
Acrobatic	6g
Primary Training	$4\frac{1}{2}$g or 5g
Small tourers	$3\frac{1}{2}$g or 4g
Large transports	$2\frac{1}{2}$g

The effect of atmospheric gusts is to produce loads on the aeroplane very similar to those occurring in manœuvres induced by the pilot. Gusts of small magnitude are met frequently, often in cloud-free air; high velocity gusts are less frequently encountered, and the highest velocities of all usually occur in or near cumulus clouds. At present our knowledge of gusts is limited and it is usual to design aeroplanes to withstand gusts of a certain velocity irrespective of their category or routes along which they fly. For small aeroplanes the gust conditions are rarely critical in the structural design but the reverse is the case for large transports. Moreover the load produced by a gust of given velocity increases as the forward speed of the aeroplanes increases. Thus as cruising speed increases, gust loading is likely to become serious penalty in design. Again the problem may partly be solved by varying the design gust velocity according to the route for which the aeroplane is intended—since the severity of gusts may prove to be somewhat a matter of locality. Secondly it is possible that improved meteorological services will enable gust producing conditions to be forecast and flights to be planned to avoid the danger area. In both cases a much more exact knowledge of atmospheric conditions becomes essential.

On the question of undercarriage design, the author believes there is still a great deal to learn about the basic loading conditions. Present design criteria are of a more or less arbitrary nature, bearing little relationship to the characteristics of the aeroplane or to its uses. A great quantity of statistical data must be collected before it is possible to improve this state of affairs, but it seems reasonable to suppose that eventually undercarriage strength and shock absorption will vary according to the category of the aeroplane. The shock absorption provided in training category aeroplanes might reasonably be greater than in other categories. Similarly the strength of the undercarriage under side loads might reasonably be related to the propensity of the aeroplane to swing.

The mechanical problems of undercarriage design are as important as, if not more important than the structural problems, and more robust and foolproof working parts, locks, and controls are very desirable. It is also probable that maintenance is as potent a factor as is design in this particular connection, but the designer can assist the maintenance engineer by providing suitable datum marks for checking alignment, instructions for filling oleo legs, and accessibility for inspection and servicing.

Power Plants.

Before the war the method of establishing the reliability of the power plant was to conduct running tests of the engine on the bench covering a wide variety of conditions of power, revs., and mixture. By examination of the engine after this endurance test it was hoped to assess, very roughly, whether the engine would be satisfactory in service if correctly operated and maintained. An obvious drawback to this procedure was that the engine mounted on the bench—more or less in laboratory conditions—was not subjected to the same external conditions as the engine mounted in the aeroplane. One conclusion is therefore that bench tests must be supplemented by endurance tests in which the engine is mounted in an airframe, with propeller, accessories, and cooling of the kind which it is intended to use in conjunction with the engine. By this means it should be possible to avoid some of the troubles associated with vibration, cooling, and fuel and oil supplies.

The problem of cooling the engine satisfactorily has always been a serious one, and this provides a good example of the way in which airworthiness must be associated with operating conditions. If an aeroplane is to be used solely in temperate zones only moderate provision for cooling is necessary; if intended for tropical use the same degree of safety can only be assured by providing much more effective cooling.

The author believes that engine failures are more often attributable to the engine accessories and the installation of the engine, than to the engine itself. Thus the rather larger proportion of accidents associated with engine failure can probably be reduced most economically by attention to details.

Stability and Control.

With two exceptions, the precise degree of stability and control provided does not appear to have a serious influence on the frequency of accidents. This may be due to the fact that if an aeroplane is reasonably comfortable to fly, its stability and control are automatically such that the aeroplane is safe to fly. Since no purchaser is likely to accept an aeroplane with unpleasant flying characteristics, the question of what is the minimum degree of control and stability for safety is rarely raised. The two exceptions to this, are stalling, and control when one engine of a multi-engined aeroplane suddenly cuts out.

Stalling. Probably a great many of the "pilot's error" accidents are due to inadvertent stalls occuring near the ground. Though no original solutions to this problem can be offered every effort should be made to devise an aeroplane in which—

(a) the stall is not violent;
(b) inadvertent spinning off a stall is impossible;
(c) the loss of height to recover from a stall is minimised;
(d) warning of the approach of the stall is given to the pilot.

Most existing safety devices which reduce stalling dangers (*e.g.* slots) tend to reduce the efficiency in other respects. It may therefore be practicable only to apply such devices to training aeroplanes where the risk is greatest and where efficiency is of less importance.

Engine Cutting. With increasing engine powers the danger arising from loss of control following the cutting of one engine of multi-engined aeroplanes becomes serious. This is a fairly new problem and it does not seem as if it should be an insoluble one. It may mean providing greater rudder power, possibly by spring tabs in large aeroplanes, and it means providing indicators to warn the pilot when the engine is cutting out, as remedial action must be taken at once if it is to be taken at all.

Simplification of controls. Great efforts have been made in the past to reduce the flying controls of the aeroplane from three to two, by coupling ailerons and rudder. Such simplification is perhaps useful, particularly in the small touring aeroplane. The out-

standing need, however, appears to be simplification of all the other controls—engine, flaps, undercarriage, propeller, cooling, etc., in the large transport aircraft. When controls must be used in a certain sequence, for instance, prior to landing, it would be advantageous to provide tell-tale instruments which automatically warn the pilot if the sequence is not followed, or even fully automatic devices which operate the controls in their correct sequence. A reduction in the number of controls is an obvious help and the required movements of the controls should be as simple as possible. Standardisation of the position of controls and instruments, in the direction of movement of controls, and of the shape of knobs associated with different controls would be valuable.

"Second line of defence" airworthiness.

If, in spite of all that can be done to prevent accidents, an accident does occur, then the consequences should be minimised. Whatever is the underlying reason for the accident, the actual direct cause of injury is usually one of the following:—

(a) Impact of the human body against a part of the aircraft;
(b) Fire;
(c) Drowning.

There are other possibilities but all rather remote. The obvious design provisions to reduce the severity of accidents are therefore:

(a) To provide safety belts which will hold the occupants in their seats in all moderate crashes. Such belts should support the occupant as completely as possible, since if properly supported the body can withstand very high accelerations without damage;
(b) To remove all dangerously shaped objects against which the body could be thrown;
(c) To provide means of escape from the crashed aeroplane after ditching or crash landing;
(d) To provide flotation gear for the occupants;
(e) To provide fire-extinguishing apparatus and to design the aeroplane to be potentially unlikely to catch fire.

There are other and better ways of providing safety in a crash than the ordinary safety belt. The most obvious is for the seats to be arranged to face backwards. Then in a crash the occupant is forced against the padded back of the seat, which spreads the loads uniformly over his body, instead of, as in the ordinary case, localising them. Unfortunately, the backward facing seat might be an unpleasant reminder of the possible crash, and not therefore a good advertisement.

Conclusion.

In conclusion it is only necessary to underline some of the suggestions already made. First, there seems no doubt that the general standard of safety can still be raised by improvement of the airworthiness of the aeroplane. If this is to be done without reduction to the efficiency of the aeroplane in other respects, the airworthiness provisions must be more closely related to the conditions under which the aeroplane operates. It is therefore suggested that the authorities can usefully devote attention to further study of:

(a) gusts in relation to localities and weather conditions;
(b) manœuvring accelerations in flight, in relation to the uses of the aeroplane;
(c) landing and take-off conditions in relation to the uses and characteristics of the aeroplane;
(d) climatic conditions, with a view to relating such matters as engine cooling and de-icing provision to the routes over which the aeroplane flies;

(e) the economics of airworthiness, *i.e.*, the best balance between the several airworthiness provisions to obtain the desired overall standard in the most economical way.

Airworthiness standards can also be raised by improvements in detailed design, probably without serious weight or other penalties. In particular improvements can be expected in:—

(a) power plant installation;

(b) simplification of controls (*i.e.* power plant, undercarriage, flap controls, etc.);

(c) undercarriage retraction mechanisms;

(d) anti-stalling devices (primarily for training types of aircraft).

Acknowledgment. The author is grateful to the Air Registration Board for permission to publish this lecture but must emphasise that the views expressed are his own.

CORRESPONDENCE

"INTERNATIONAL AIR TRANSPORT AND NATIONAL POLICY."

To the Editor.

Dear Sir,—I have recently read through Oliver J. Lissitzyn's book "International Air Transport and National Policy"* with considerable interest. There is a particular aspect upon which I would like to comment, namely, the high cost of air transport. The author makes the point (on several occasions) that civil air transport is primarily an instrument of national policy and that, in consequence, a Government is satisfied to defray, out of the public purse, operators' losses by means of deficit-covering subsidies (direct payments or by mail contracts)—not, indeed, to enable the operators to make high profits but in order to keep air lines alive—for military, diplomatic, political and general prestige purposes. The author also suggests that in the circumstances that exist, the commercial aspect of air transport, *i.e.*, its return to investors, appears to be secondary to its national importance. Incidentally, its service to the public would also appear to be of somewhat secondary importance, although the author does not make this point.

With all due regard to the erudition and well-balanced arguments of the author, I cannot help feeling that he may be putting the cart before the horse. In a liberal economy, such as has been practised in this country and U.S.A. for the past two centuries or more, the profit-motive is regarded as legitimate, and it certainly tends to promote enterprise and to foster initiative. But if air line operators can operate in the sure belief that if they provide only reasonably satisfactory services the Government will keep them alive, for national purposes, by means of deficit-covering subsidies, the urge towards improvement and progress is likely to disappear. Not only would competition between operators of the same nation tend to become ineffective but foreign competition could be equally disregarded. (This state of affairs, I suggest, actually obtained in Imperial Airways during the period before the Empire mail scheme was introduced.) It does not seem to forecast any bright prospect for civil air transport.

It is true that in spite of the foregoing conditions in U.S.A. the operators there seem to be very much alive, but I cannot help thinking that the principle itself, *i.e.*, of keeping them alive and nothing further, is unsatisfactory and unsound. The fact that it is adopted at all arises from the difficulty of covering costs by income in the existing state of air transport development. Even in U.S.A., where air transport progress has been greatest, one looks in vain for evidence that it pays its way on any comprehensive scale, free of Government support. Nor is there any sure evidence that it will succeed in doing so for any predictable period after the war, in spite of optimistic statements to the contrary.

If one looks back at the beginnings of civil air transport in this country, in 1920, the outlook of operators, legitimately activated by the profit-motive, was service to the public, combined with an enthusiasm that was unfortunately damped by a succession of serious losses. Not only did the Government from the outset decline to recognise any obligation or any expediency to provide subsidies until all the chief air lines had been compelled practically to close down (nor even to provide adequate ground and meteorological aids) it expressed the view that air transport must fly by itself,

* Published by the Council on Foreign Relations, New York.

i.e., be self-supporting. When it became obvious that this was impossible the Government, somewhat grudgingly, embarked upon a limited course of subsidization. The experience was somewhat similar in other countries. It was probably at that point that our Government in common with the Governments of other countries, generated the idea that air transport might be used as an instrument of national policy. This idea appears gradually to have taken root and, as Oliver Lissitzyn claims, it now overshadows all other objectives.

Anybody who has followed the history of air transport is quite well aware that it was unable to become self-supporting because of its high working costs. It is true that first-class service was not always provided but this was often the consequence of inadequate funds, for there was at no time any inherent difficulty in providing regular and punctual services. For example, regularity and punctuality often suffered simply because the Government was indifferent about providing adequate ground facilities, not because aircraft could not do their job. The net result to operators was a choice of two alternatives, either to charge fares so high that they could not attract an adequate volume of traffic, or else to run at a loss, meantime hoping for something to turn up.

The position as regards high costs is not much different at the present day, and I think that the new crop of enthusiasts, represented to a large extent by the shipping companies and railways, might well consider whether it is wise to proclaim that they can run without subsidies until they have delved thoroughly into costs and have made traffic estimates that are reasonably conservative. Although the State provides ground facilities there is no sure evidence to show that air lines can be self-supporting, unless over exceptionally favourable routes. In other words, income cannot yet cover costs. If it can, I would be most interested to examine the evidence.

This state of affairs, I submit, enables the Government to step in and maintain an unduly strong hold over civil air transport. In exchange for subsidies it demands, not merely a reasonable degree of regulation, but control and even management, *i.e.*, we have bureaucratic control and management, we have conditions in which air transport is shackled and is not free to develop and, as Lissitzyn points out, it inevitably remains an instrument of national policy and little else.

The chief remedy, so far as I can see, lies in reduction of costs, which can be gradually brought about by technological advances, by improvements in operational and maintenance technique, and by developing new uses for air transport (freight, for example, which has been comparatively neglected). Once a point has been reached by these means, that will enable air transport to pay its way, although it may still remain an instrument of national policy it will have freed itself from financial reliance upon the State and will have greater opportunities of operating commercially, like any other form of desirable private enterprise.

This objective is much to be desired and we must look to our technicians, our operators, and our traffic specialists gradually to free air transport to enable it to take its proper place alongside other progressive commercial developments. So long as its economic losses, and even the dividends it pays to investors, are a burden upon the public, air transport is likely to remain in an unhealthy and artificial condition.

Yours faithfully,

PHILIP G. MARR.

12th May, 1945.

To the Editor.

8th June, 1945.

Dear Sir,—I have read with interest Mr. Wright's paper on "Wheels and Brakes" and the discussion that arose from it. I noted that several speakers mentioned the type of operation and that Mr. Wright would welcome some pilots' views on this point.

It is interesting to note that I was asked this very question by B.A.L.P.A. a few months ago when they were compiling a concensus of opinion on general points of cockpit layout. It also happens that my personal views coincide almost exactly with their final report which they compiled from some 200 British air line pilots stationed throughout the world.

I have tried during the past few years most of the normal types of brakes, and in particular recently the British pneumatic type and the American toe-operated hydraulic type. There is no doubt in my mind that the power-driven toe-operated brake is the best for the very reasons given by Group Captain Scroggs and Mr. Parker in the discussion, namely, ease and quickness of control, positive action and ability to lock the flying controls—a particularly useful point in large aircraft where control surfaces can take charge in strong cross or down wind manœuvres.

My experience of present installations favours hydraulic power, as with this system there seems less likelihood of losing all pressure after a long ground movement than with the present pneumatic installations. In general it is very noticeable when garnering information from pilots that they are a very conservative body and unless they have tried several schemes they are liable to back the one they know rather than one they do not, regardless of the possibilities of the latter.

I hope these few remarks cover some of the points raised by Mr. Wright in his question.

Yours faithfully,

VERNON A. M. HUNT, A.F.R.Ae.S.,
Captain, B.O.A.C.

Whitchurch Airport, Bristol.

To the Editor.

24th May, 1945.

Dear Sir,—Major Green's article in the Journal for April, assumes that the weight saved will be used to increase the size of the aircraft. This is unlikely as the air liner will be designed to carry a certain number of passengers and load of freight. Any saving in weight will probably be used merely to reduce operating costs or in certain cases increase the freight load.

It is also taken that lightening the components will increase the cost of the aircraft. This is possibly true of machined fittings and lightening holes, but the reverse is the case when weight is saved by the use of lighter gauges, etc. On the whole the difference in cost will probably not be appreciable.

Another approach to the problem is to translate the weight saved into terms of drag and operating costs directly.

Consider a typical air liner cruising at a constant L/D of 14 at a height of 10,000 ft. At the beginning of flight the speed would be 210 m.p.h. T.A.S.; after 1,000 miles 200 m.p.h. T.A.S.; after 2,000 miles 190 m.p.h. T.A.S.; and at the end of 3,000 miles 180 m.p.h. T.A.S.

Each pound of weight saved is equivalent to saving 0.0715 lb. of drag, which for a mean speed of 205 m.p.h. for 1,000 miles range is equivalent to

$$(0.0715 \times 300)/(0.8 \times 550) = 0.0488 \text{ b.h.p.},$$

assuming a propeller efficiency of 0.8.

With a specific fuel consumption of 0.5 pts./b.h.p./hr. and using Major Green's figures of 3,000 flying hours per year for five years (although the flying hours are conservative for what it is hoped to obtain in post-war air line operation) the fuel saved during the life of the aircraft from a saving in weight of

$$1 \text{ lb.} = (0.0488 \times 0.5 \times 3{,}000 \times 5)/8$$
$$= 45.8 \text{ gallons.}$$

Assuming fuel to cost the airline operator 1s. 6d. per gallon, the value of the pound of weight saved is thus approx. £3 9s. 0d. As the range increases and the mean cruising speed is decreased the value decreases slightly, but if the speed is kept constant

at 210 m.p.h. T.A.S. throughout the range the value will increase somewhat.

By increasing the aerodynamic cleanliness of the aircraft and thus increasing the ratio L/D the value of each pound of weight will also be somewhat reduced.

This treatment no doubt simplifies the problem of cost to some extent in so far as the variation in original cost is neglected, but as already stated it is doubtful if this has any important bearing on the value.

If the weight saved is used to increase the freight load, which implies operating always at full load (a most desirable but unlikely state of affairs) the value of each pound saved is simply equal to the cost per pound of freight over the number of miles covered in the " life " of the aircraft, that is approximately

$$3{,}000 \times 5 \times 200 = 3{,}000{,}000 \text{ miles.}$$

Again, taking Major Green's figures of 3d. per passenger mile (with a passenger plus baggage weighing 220 lb.) or

0.01365d./lb./mile,

the value of each pound saved would be approximately £170, similar to the American figure quoted by Major Green. This is correct if full loads could always be assured, but as this is most improbable, the former estimate gives the more reasonable value.

Yours faithfully,

EDWARD LOVELETT.

To the Editor.

11th May, 1945.

Dear Sir,—Major Green's paper on weight saving is very interesting and opportune. We must increase the efficiency of our new aircraft as much as possible if we are to compete successfully in the international market. It is hoped that the many production engineers who have come into the industry during the war period will read the paper.

The majority of people in the aircraft industry or even in the design offices, do not believe that weight saving is so important. It should also be emphasised that it is against the immediate interests of the majority of people in the industry to reduce weight. The draughtsman must reduce his clearances and thus risk fouls. The detail stressman runs more risk of someone else finding the part weak and his work will be increased many times. The works are faced with profiling instead of straight cuts, manipulating thin material, using high grade materials which require extra heat treatments and are more difficult to machine. Inspection departments are faced with more inspection operations and the necessity for scrapping a much larger proportion of work.

Managements and directors are faced with delay: delay in getting drawings out; delay while methods of manufacturing the fragile parts are worked out; delay due to scrap. The maintenance engineer is faced with an aircraft with reduced accessibility and with the necessity of providing and using much more equipment. All these individuals are against weight saving and they are continually bombarding the designer. They say " we are cutting it too fine," " a casting will be easier," " can't we have a straight cut here," " the thing is too fragile it will get damaged in the stores," " we can't weld this it is too thin, we must have allowance for over-size bolts," etc., etc., and perhaps the most dangerous cry of all from the efficiency point of view, " we must get the drawings out " (one can add " somehow " or " anyhow " under one's breath). The fact is that because weight saving is so important these common sense statements must be largely ignored. The aircraft must be unsatisfactory on the ground, to a certain extent, in order to achieve efficiency in the air.

The criterion of a guinea per oz. should be applied to the aircraft from the very beginning, especially by those who write the specifications. A large number of small items such as special slinging and jacking

points, the splitting up of aircraft into small pieces for ease of transport and manufacture, the provision of large doors for ease of maintenance, and of cowls sufficiently robust to stand jumping on, the provision of unnecessary flooring (especially on wing surfaces), the specification of margins in fuel and oil and water, etc., all these things and many more (especially in the case of the Fleet Air Arm) reduce the efficiency of the aircraft before it is begun. Maintenance engineers must also be educated to the idea that the aircraft they are servicing is worth a (marginal) guinea an oz. They should never tread on the aircraft anywhere if the work can be done without doing so. A great deal more money should be spent on staging and ground equipment generally to avoid adding a few ozs. to the aircraft. It is suggested that a bonus on weight saving could be given to the design offices as well as to outside equipment manufacturers. Junior draughtsmen must be trained to make every dimension on their drawings as small as they reasonably can.

Before dimensional tolerances can be reduced a great deal of tightening up will have to be done first of all to ensure that the article produced really is to drawing tolerances.

In short an improvement in our standards of workmanship in the shops and the drawing office is necessary and it must take place quickly.

If this paper of Major Green's helps to convince some of those who are in power in the aircraft industry that weight saving is worth money to them, it will have served a very useful purpose.

Yours faithfully,

A. H. CRAWSHAW, A.F.R.Ae.S.

REVIEWS

The Aircraft Servicing Manual.
T. G. Preston and G. W. Williamson. Paul Elek (Publishers), Ltd., London. 1945. 10/6 net.

T. G. .Preston is a first officer in Air Transport Auxiliary and G. W. Williamson served as chief engineer in the same service, so they write with considerable authority on a subject of ever-increasing importance.

A very considerable amount of accurate and useful information has been compressed into the 120 pages of this manual. Chapter I deals with safety in flight, the organisation necessary of the A.I.D. and A.R.B., aircraft licences, maintenance, modifications and repairs, overhauls and renewal of certificates of airworthiness. Chapter II is concerned with airframe construction and erection. Chapter III with controls, undercarriages, tyres and brakes. Chapter IV with instruments, electrics, de-icing and fire protection. Chapters V and VI with aero engines, accessories and maintenance, and the final chapter with maintenance and inspection of complete aircraft.

Naturally, in a book of this size, it is not possible to go into all the hundred and one details which are so necessary in the full overhaul, maintenance and servicing of aircraft and aircraft engines, but the authors have prepared an excellent foundation upon which those concerned with airworthiness can build with confidence. The book has a useful index which adds to its value as a work of reference, and a list of books of use to licensed aircraft engineers.

Spherical Trigonometry for Navigators.
By Charles Williams, M.A. (Oxon). Sir Isaac Pitman and Sons, Ltd. 1945. 5/-.

One of the difficulties with all aeronautical literature is that whenever a book is published it caters for a demand already three or four years old. This can certainly be said for Mr. Williams' book.

No attempt has been made to make the title an excuse for providing a text book of spherical geometry, the contents being well selected to give every thing the navigator or navigational teacher requires with no unnecessary information. Little previous mathematical knowledge is required to obtain full understanding of the text and Mr. Williams has taken great pains to make his figures as visual as possible. It is a great pleasure to see examples worked out in the type of problem which will confront the navigator and not in the purely theoretical values of school trigonometry.

Altogether the book succeeds in its purpose and should prove useful to all who are interested in this practical problem.

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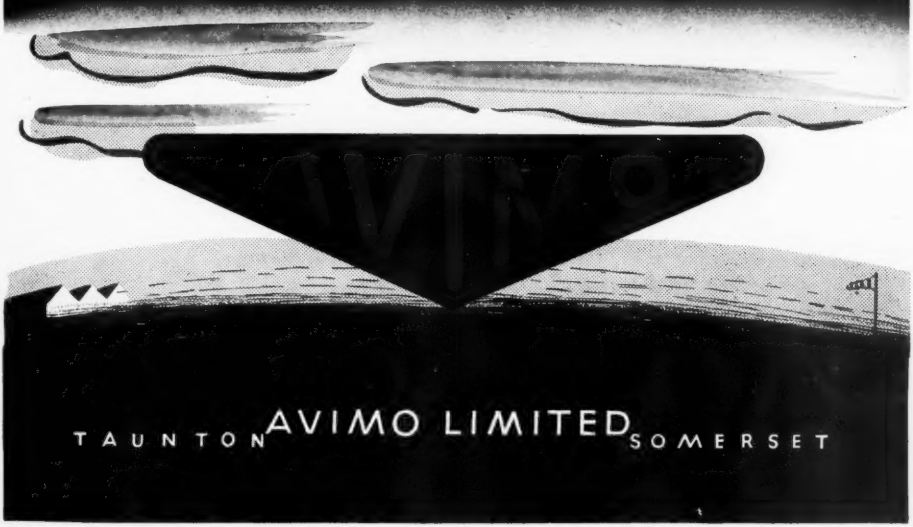

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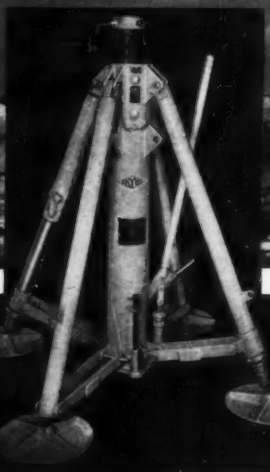


Stirling clear of Soft Ground. Forward Towing Attachments being made.

Designed & Manufactured by

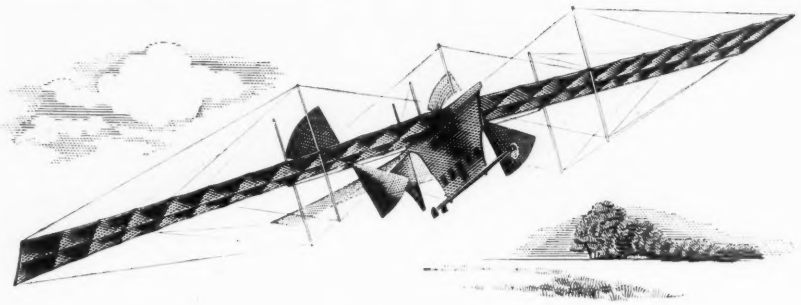
HENRY MILLER & CO.

'SKYHI' WORKS, STANDARD ROAD,

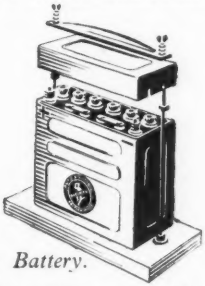
PARK ROYAL, LONDON, N.W.10.

Telegrams: "SKYHIJACK PHONE LONDON" *Telephone:* WILLESDEN 1302/3/4

PIONEERING



AS HENSON, whose 25-h.p. steam-propelled aeroplane of 1843 is illustrated above, ranked among those who pioneered aviation, so the makers of Dagenite batteries pioneered the construction of AIRCRAFT ACCUMULATORS. To-day, because they embody the results of a rich experience, Dagenite batteries are an essential of the most modern aircraft.



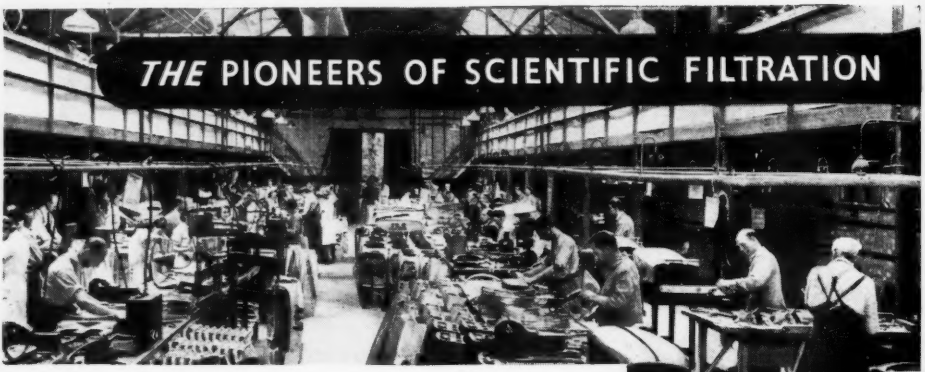
Illustrated is the Dagenite Aerobatic Unspillable Battery. Other types for the aircraft itself and for ground starting are supplied.

DAGENITE

AIRCRAFT BATTERIES

PETO AND RADFORD, 50, GROSVENOR GARDENS, LONDON, S.W 1

PR3D/45



As we have said before

really efficient filters are not mere gauze and fabric devices. We, of Vokes, who have won the reputation of producing the finest filters in the world, do not simply stitch together such materials and cut and fold the results into convenient shapes. Each type of filter is carefully designed for its particular job ; it is the consequence of successful research and experiment, and of a quarter-of-a century's specialised manufacturing experience.

For instance, each of the air filters we have produced during the last twelve years for no less than 87 types of British and American aircraft ; each possessed its own separate problem, its own special requirements. Many filters had to be fitted to aircraft already in production.

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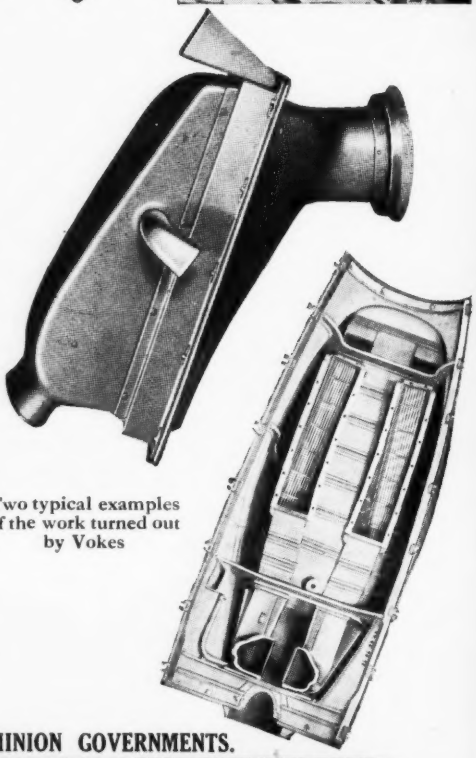
You can trust the 99·9 per cent. efficiency of a Vokes' Filter. The Fighting Services do ! Vokes manufacture over 3,000 models to meet all possible needs.



Two typical examples of the work turned out by Vokes

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